FLYING
including INDUSTRIAL AVIATION

OCTOBER, 1943

VOLUME 33 • NUMBER 4

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ZIFF-DAVIS PUBLISHING COMPANY

Editorial Offices, 540 N. Michigan Ave. Chicago, 11, Ill.
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Special Issue

U. S. ARMY AIR FORCES AT WAR

WILLIAM B. ZIFF
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FLYING is published monthly by Ziff-Davis Publishing Company at 540 N. Michigan Ave., Chicago, Ill. New York Advertising Office, 270 Madison Ave. West Coast Advertising Representative, William L. Pinney, 416 W. Eighth St., Los Angeles, Cal. Canadian Advertising Representative, G. J. McGoey, 21 King Street, East, Toronto. London Advertising Representative, J. Forecast, Edwin Greenwood, Ltd., 23 Strand, London. W.C.2. London editorial representative, A. Spenser Allberry. Washington office, Earle Building. Special Washington representative, Lieut. Col. Harold E. Hartney, Occidental Hotel. SUBSCRIPTION RATES: In U. S., $3.00 per year, single copies 35 cents; in South and Central America and U. S. Possessions, $3.00 per year; in Canada, $3.50 per year, single copies 40 cents; in British Empire, $4.00 per year. All other foreign countries, $6.00 per year. Subscribers should allow two weeks for change of address. Address all subscription letters to the Director of Circulation, FLYING, 540 N. Michigan Ave., Chicago. Entered as second class matter September 8, 1942, at the Post Office, Chicago, Illinois, under the act of March 3, 1879. Entered as second class matter at the Post Office Department, Ottawa, Canada. Contributors should retain copy of contributions. All submitted material must contain return postage. Contributions will be handled with reasonable care, but this magazine assumes no responsibility for their safety. Accepted material is subject to whatever adaptations and revisions are necessary to meet requirements. Payments cover all authors', contributors' and contestants' rights, title, and interest in and to the material accepted and will be made at our current rates upon acceptance. All photos and drawings will be considered as part of material purchased.

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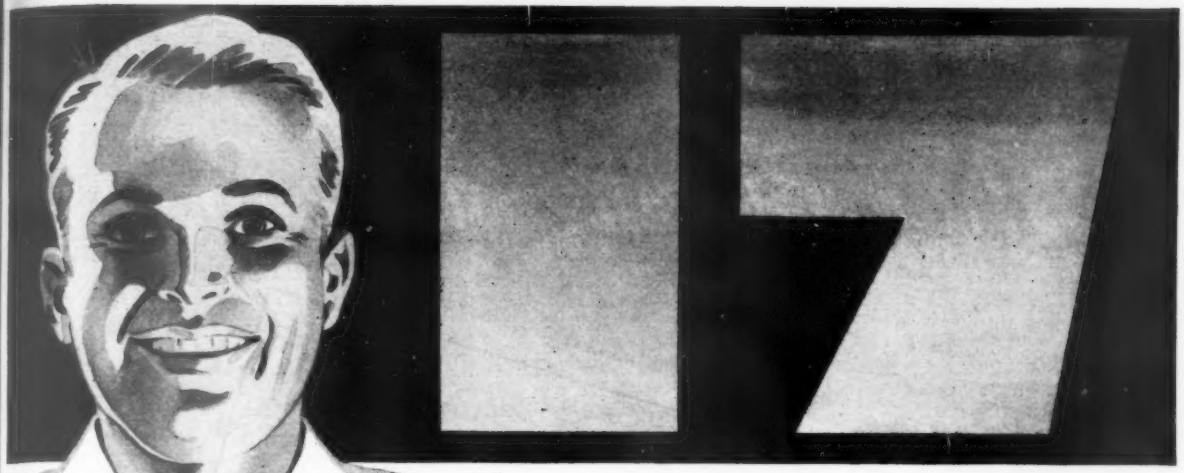

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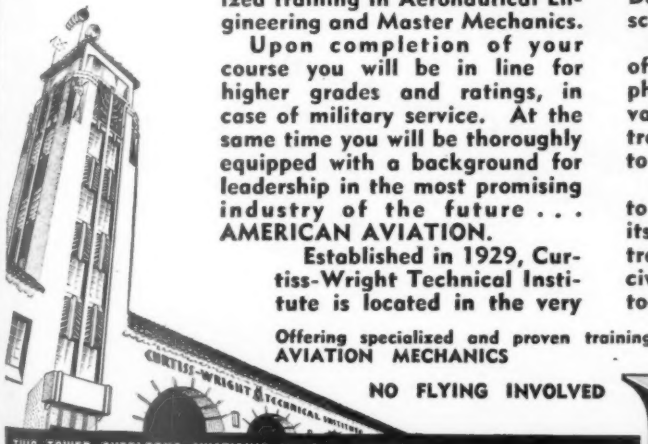

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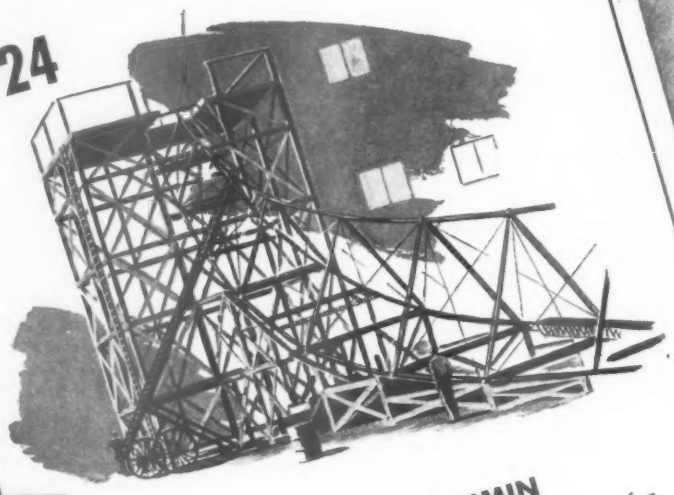
Trail Blazing in the Skies

1924



THE FIRST USE OF DURALUMIN IN AIRCRAFT — by a private American manufacturer — was in the keel of the Army semi-rigid airship RS-1, built by Goodyear in 1924. So little was then known of the technique of working duralumin, Goodyear engineers spent a year developing methods of forming, heat-treating and riveting the metal—before beginning work on this keel. Many of these practices first pioneered by Goodyear are now standard in duralumin aircraft construction.

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1943

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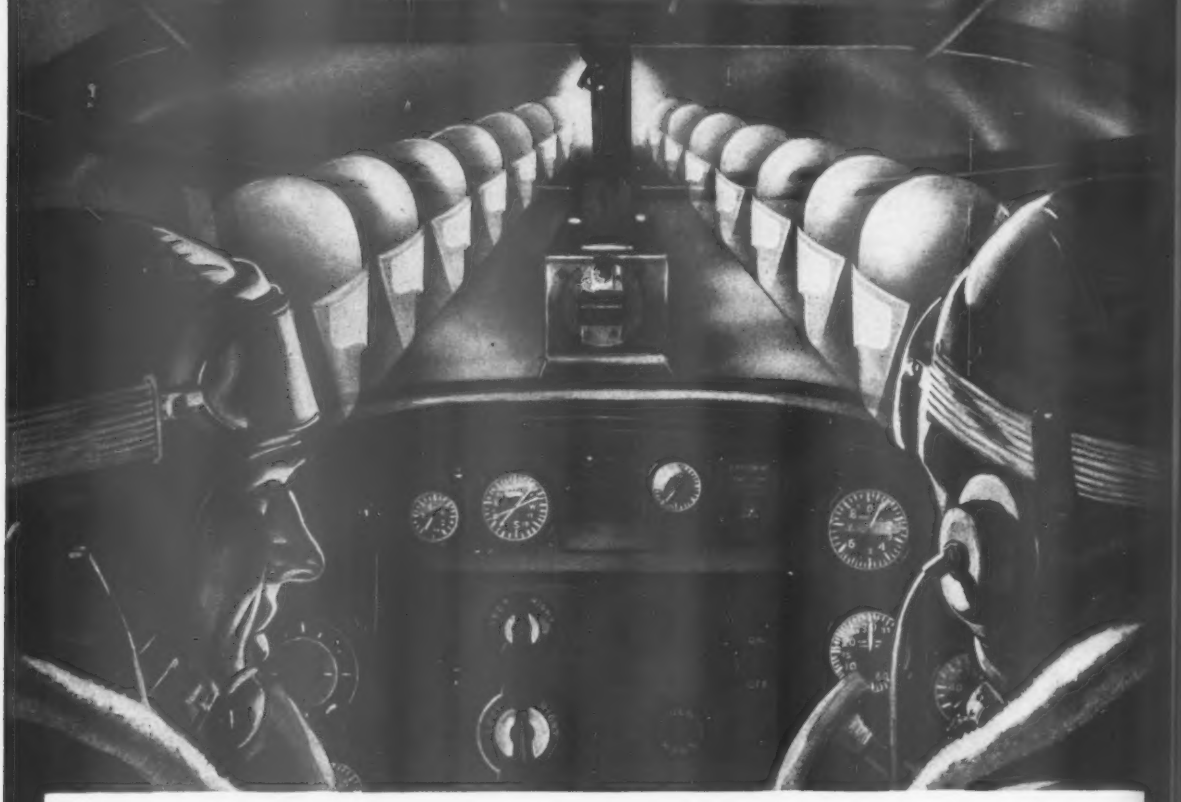

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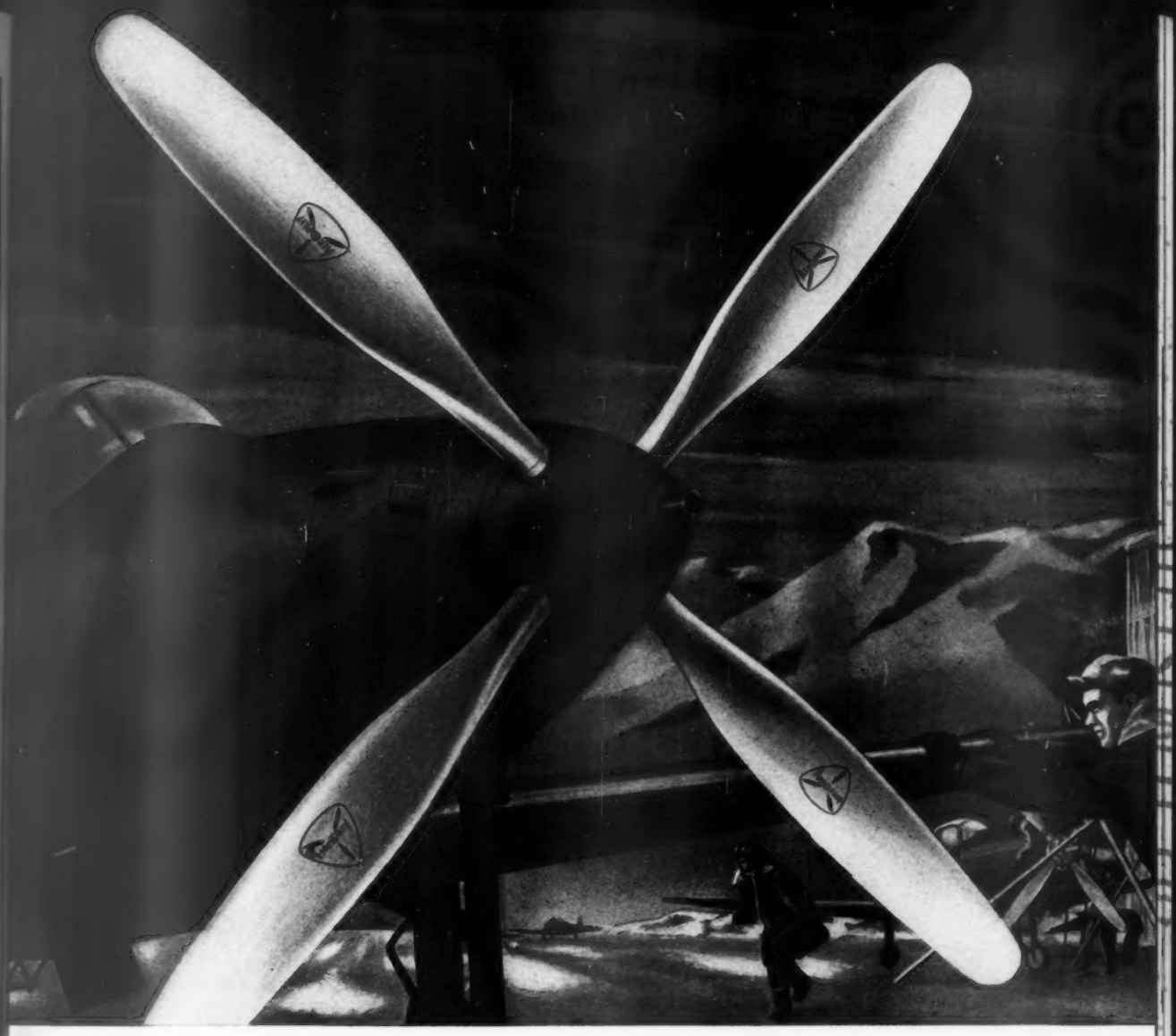

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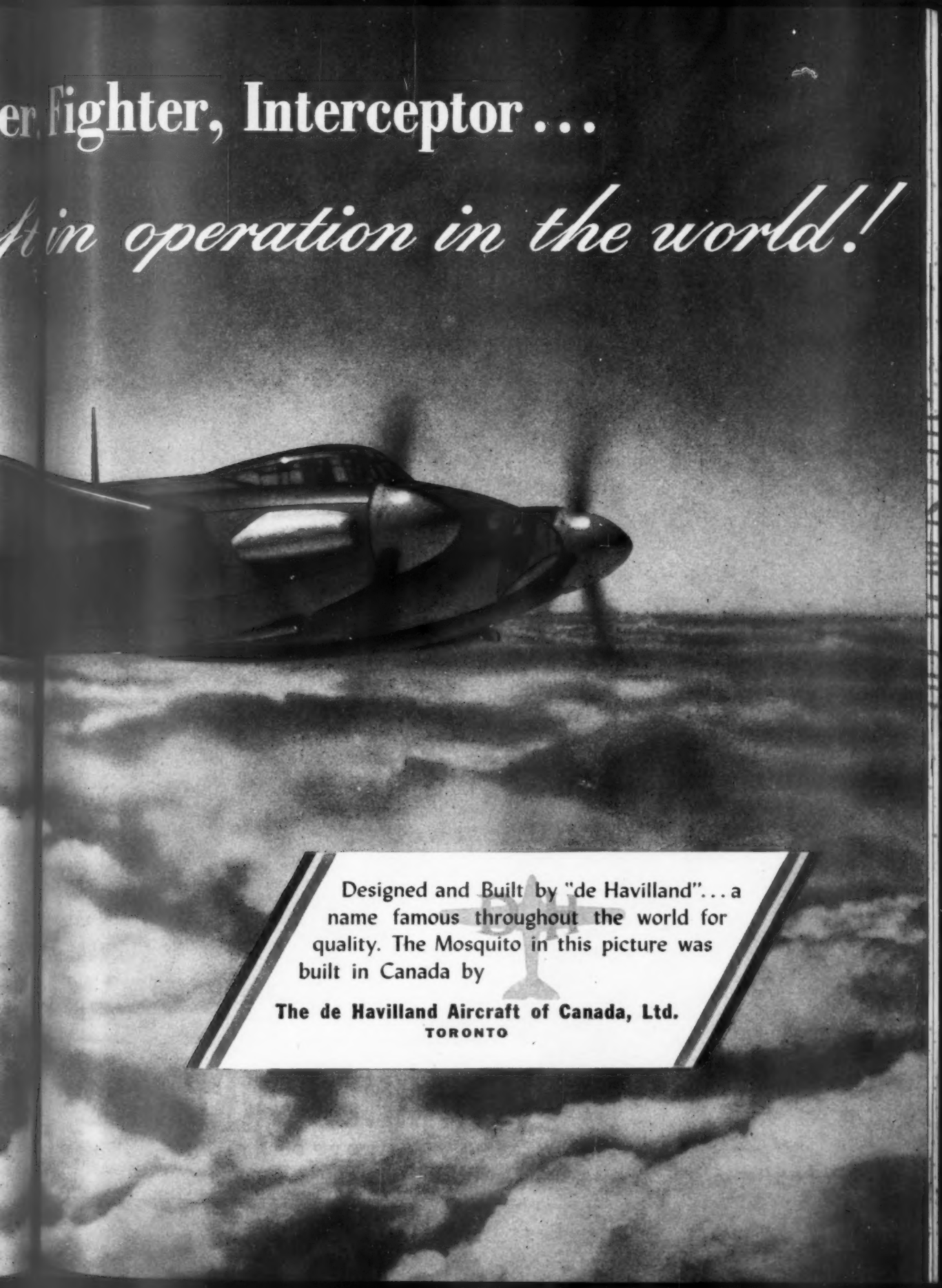
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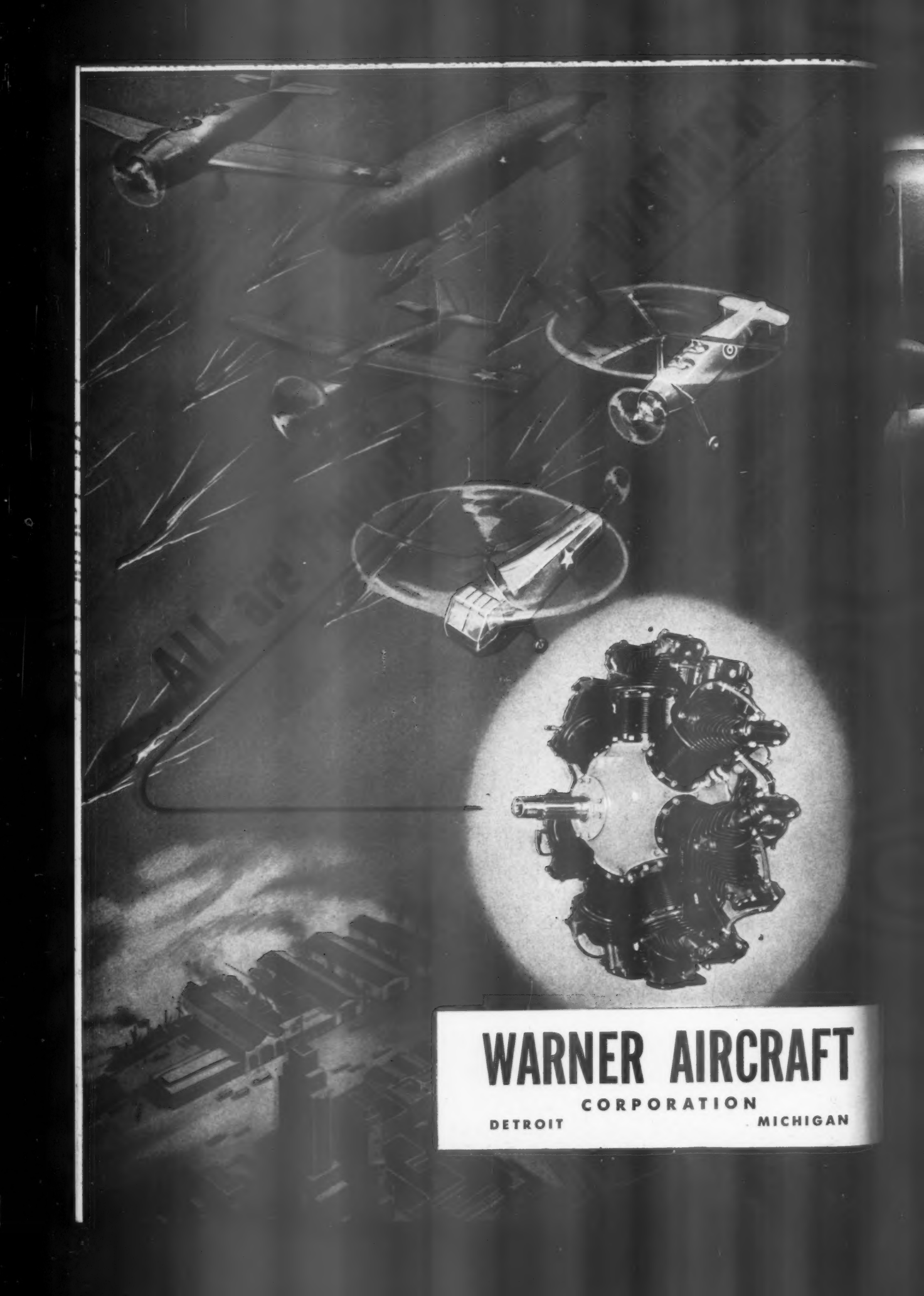

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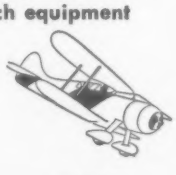
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Textbook, Classroom Charts and Printed Lectures on

DIMENSIONAL CONTROL

Dimensional Control covers the subject of gages and their application to industrial inspection in addition to the development of sound gaging policy.

The 80-page book, the visual portfolios of 46 classroom charts, 27″ x 32″, and the 28-page printed lecture manual will readily provide the necessary material to organize and conduct training classes for inspectors and shop men engaged in precision manufacture. Book, charts and lectures have been recently revised to bring them up to date. All are now being enthusiastically used in training courses from coast to coast.

The textbook, "Dimensional Control," is available to students at $1.50 per copy. The charts, mounted on an easel and including the lecture manual, are priced at $3.50 per set. All prices are postpaid in the U.S.

The supply of all this material is limited and the curtailment of paper supply makes further editions problematical. Better order what you need now.

THE SHEFFIELD CORPORATION

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Please send me_____copies of "Dimensional Control" for which I enclose purchase order or $_____ ($1.50 per copy postpaid).

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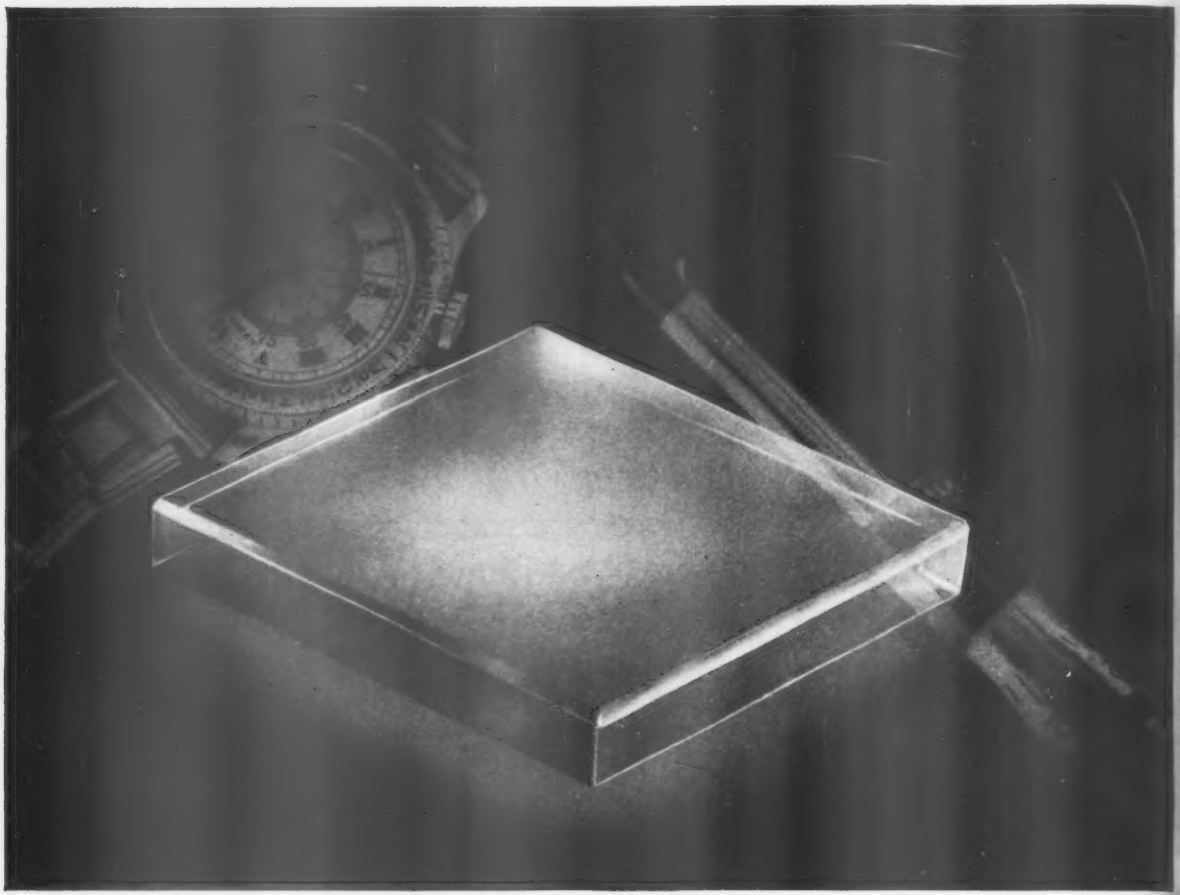


Every RCA Aviation Radio Crystal Is a Masterpiece of Accuracy

TO NAVIGATORS of the skyways and ocean lanes a fine chronometer is the ultimate of accuracy. To the expert machinist a good micrometer is the symbol of precision. Both of these instruments are, indeed, highly accurate; yet finer still is the precision required of good aviation radio equipment.

An example of this high degree of accuracy is the quartz crystal plate shown above. Crystals like these are used to keep radio transmitters, and in some cases receivers, operating at their proper frequency.

To do this efficiently the quartz plates must be cut and ground with extreme accuracy. Only very minute tolerances can be allowed. Precision work in other lines ordinarily requires measurements no finer than one ten-thousandth of an inch. But RCA crystals are measured in microns, and fractions of microns, and one micron equals only *40 millionths* of an inch.

A very slight error will make a difference of thousands of cycles in the crystal frequency controlling the oscillator circuit. Conventional measuring instruments are useless for this work. That is why, for production of RCA crystals, RCA engineers have devised special means, such as X-rays, greatly magnified micrometers, and electronic devices.

RCA crystals are made with such precision that operating frequencies can be held to two ten-thousandths of one per cent! *Thus the crystal vibration frequency will not vary more than* 3 *cycles in* 1,000,000.

With wear and aging, mechanical devices lose their initial accuracy. Yet crystals which are properly cut and carefully ground will maintain their original accuracy indefinitely. Thus precision of RCA crystals is maintained at all times, assuring you of permanent accuracy.

So, too, every other factor affecting performance of aviation equipment is worked out with meticulous exactitude by RCA engineers—through every step of theory, every operation in manufacture. That is why aviation engineers say confidently, "RCA Aviation Radio Equipment is dependable. You're 'on the beam' when you consult RCA research!"

RCA

RCA AVIATION RADIO

RCA VICTOR DIVISION • RADIO CORPORATION OF AMERICA • CAMDEN, N. J.

The Columbia won every event in its class at the 1926 National Air Races. In 1927, Clarence Chamberlin flew it from Long Island to Germany. In 1930, Capt. Errol Boyd and Lt. Harry Conner flew it from Newfoundland to England.

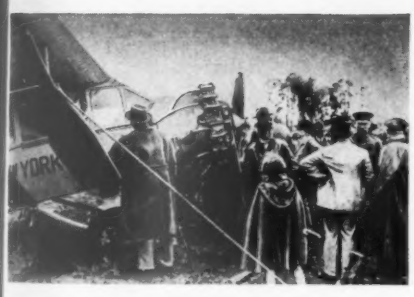
4,000 MILES NON-STOP FLIGHT TO GERMANY

U. S. Army Air Forces Photo

This remarkable combat photo shows one of the unescorted B-17's in a fleet that rained destruction on the U-boat base and shops at Wilhelmshaven. Many of these powerful U. S. Army Eighth Air Force planes flew from America to England before they started their round-the-clock high level precision-bombing tasks over Germany.

Here is the answer to all Germans who thought America was "too far away." Had the Nazi leaders been a little brighter, they might have feared us sooner. Sixteen years ago, in 1927, a clear sign of American air prowess appeared in the German skies. It was the famous Bellanca long-distance cabin monoplane which flew over 4,000 miles to Germany in 42 hours and 45 minutes, non-stop, setting a world's record.

Today, the Bellanca tradition marches on in the production of the AT-21-BL gunnery crew trainer—precision-built armament equipment—and aircraft components for many of the United Nations bombers that are fighting for freedom in every theatre of this global war.



Above: at Kottbus, southeast of Berlin, where Pilot Chamberlin landed en route to Tempelhof Field, the Columbia gives this curious crowd something to think about. Below: the AT-21-BL gunnery crew trainer, now in production for the U. S. Army Air Forces.

KEEP ON BUYING U. S. WAR BONDS

BELLANCA AIRCRAFT CORPORATION

NEW CASTLE, DELAWARE

Aviation Needs You as a Trained W

SPARTAN Specialized Training Can Equip You for a Splendid Lifetime Career in the Scientific Profession of Meteorology

Here's opportunity with a triple advantage! As a trained weather forecaster—(1) you can secure an important position in America's great aviation industry—(2) you can be of far greater value to your country when called to military service—(3) you can be ready for a splendid lifetime career as a professional meteorologist in the promising post-war era.

There is an increasing need for trained weather forecasters in aviation. The U. S. Army Air Forces, the Civil Service and the Airlines are experiencing a critical shortage of meteorologists. Graduates of the Spartan School of Meteorology are stepping into good-pay positions in weather stations of the airlines and other branches of the aeronautical industry. Others have received rapid advancement in the armed forces and now hold commissions.

Exceptional opportunities are ahead **for both men and women** in this scientific field—and the School of Meteorology of the SPARTAN School of Aeronautics has the modern training facilities and skilled instructors you need for the right start and a successful future. Four fluorescent-lighted laboratories are completely equipped. Students receive skilled personalized instruction and practical experience that can be directly applied to the needs of the aviation industry.

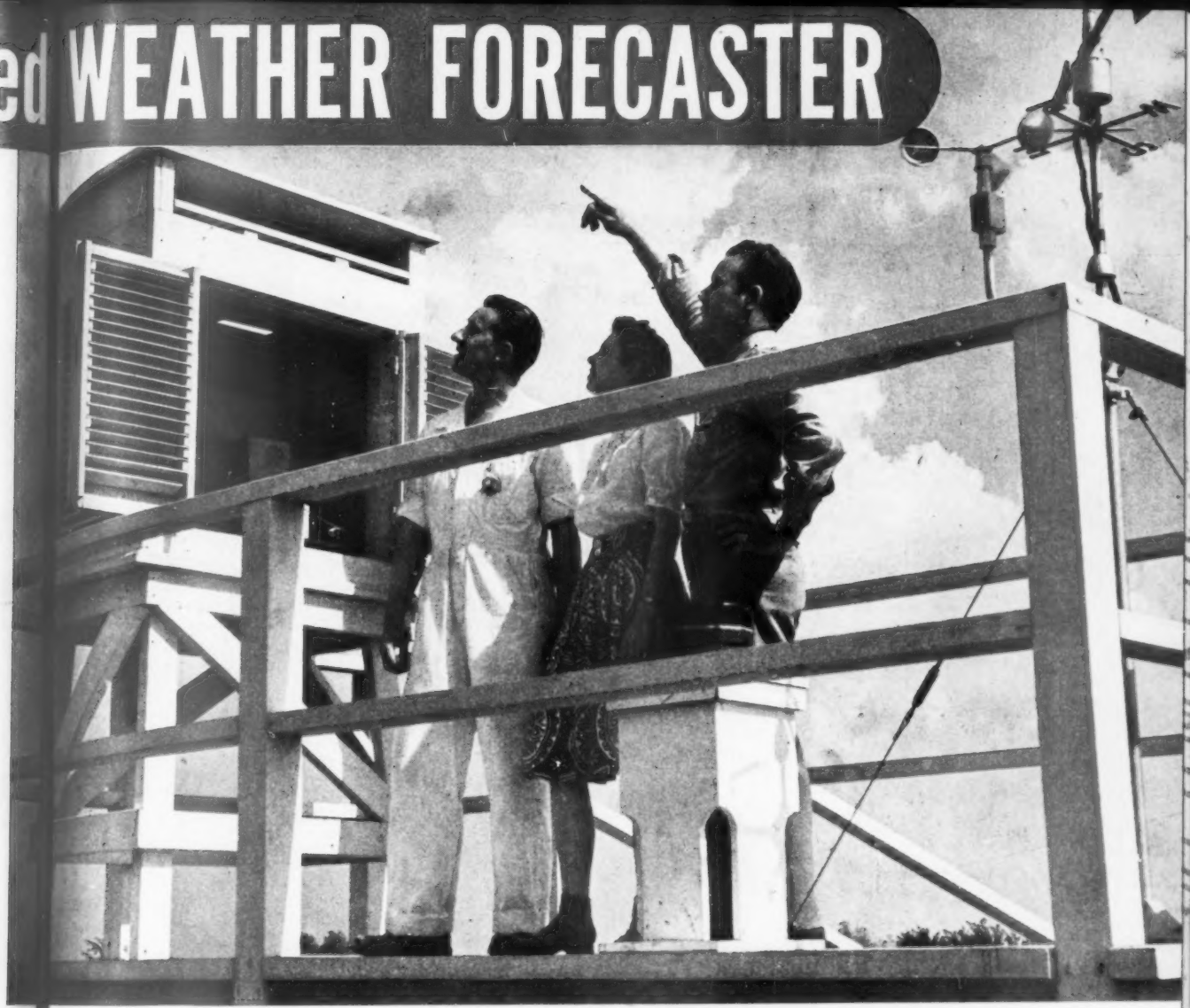
★ **Meteorology Considered Essential to the War Program**—Every consideration for deferment from selective Service is extended to meteorology students, many of whom join the Air Forces as technical specialists, as instructors in Air Forces training schools, airlines handling the ferrying of aircraft to different parts of the world, the Weather Bureau, and other agencies of the government.

★ The SPARTAN School of Meteorology has received high praise from the Air Forces, Civil Service and Airline meteorology department heads for the thoroughness of instruction, methods of training, wealth of modern equipment, and quality of graduates produced. Start your meteorology training at SPARTAN at once—to increase your value to America now—to be ready for lifetime career after the war.

SPARTAN and COLLEGE OF

SPARTAN SCHOOL Salutes the U. S. Army Air Forces for their grand and glorious accomplishments on the fighting fronts. Since July 1, 1939, Spartan School has been training aviation cadets for the U. S. Army Air Forces. Flying is done from six auxiliary fields in the vicinity of Tulsa,

ed WEATHER FORECASTER



The Spartan Weather Observation Tower

SPARTAN also offers you superior specialized training for these aviation careers: Commercial or Airline Pilot, Flight Instructor, Aircraft or Engine Mechanic, Aeronautical or Airline Maintenance Engineering, Radio Communications and Instrument Technician.

Continue your education at this "University of Aviation" where you are assured advantages obtainable at no other school of its kind. Next semester in Weather Forecasting starts Sept. 27th. Next semesters in other courses start September 20th and January 3rd.

SCHOOL OF AERONAUTICS

DIVISION OF SPARTAN AIRCRAFT COMPANY

AERONAUTICAL ENGINEERING

DIVISION OF SPARTAN SCHOOL OF AERONAUTICS

SPARTAN SCHOOL OF AERONAUTICS—Capt. Maxwell W. Balfour, Director, Address Dept. F-103, Tulsa, Oklahoma

Send me your new Catalog, describing in detail the SPARTAN courses I have checked, also stating tuition and living expenses.

Name.....Age.....

Address.....

City.....State.....

Previous Education.....

CHECK COURSES YOU PREFER

- ☐ Aeronautical Engineering
- ☐ Airline Maintenance Engineering
- ☐ Commercial Pilot
- ☐ Commercial Flight Instructor
- ☐ Airline Service Mechanic (A&E)
- ☐ Instrument Technician
- ☐ Airline Pilot
- ☐ Aircraft or Engine Mechanic
- ☐ Radio Communications
- ☐ Private Pilot
- ☐ Weather Forecasting
- ☐ Women's Instrument Technician

INSURING

PEACETIME practice will reap profitable advantages from the lessons forced by the pressure of war. Airport snow removal will be no exception.

Commercial flyers should watch military practice on fields both in this country and Canada and they will find that the flexibility of Snogo is fitting it into the picture as the fastest method of snow removal, whether it means cleaning the runway or using the field as an "allway field."

Snogos are keeping runways clear on airports of all sizes. Snogo does not pile up banks to endanger wing tips. When Snogo gets through, the job is done and there is no heavy snow blanket calling for continuous compaction tests, or reconditioning for rerolling and sanding. There is no packed layer to freeze into dangerous ruts that must be scarified or thaw into rotten danger spots and provide slush that can be picked up by wheel pants and freeze in wheel wells or brakes.

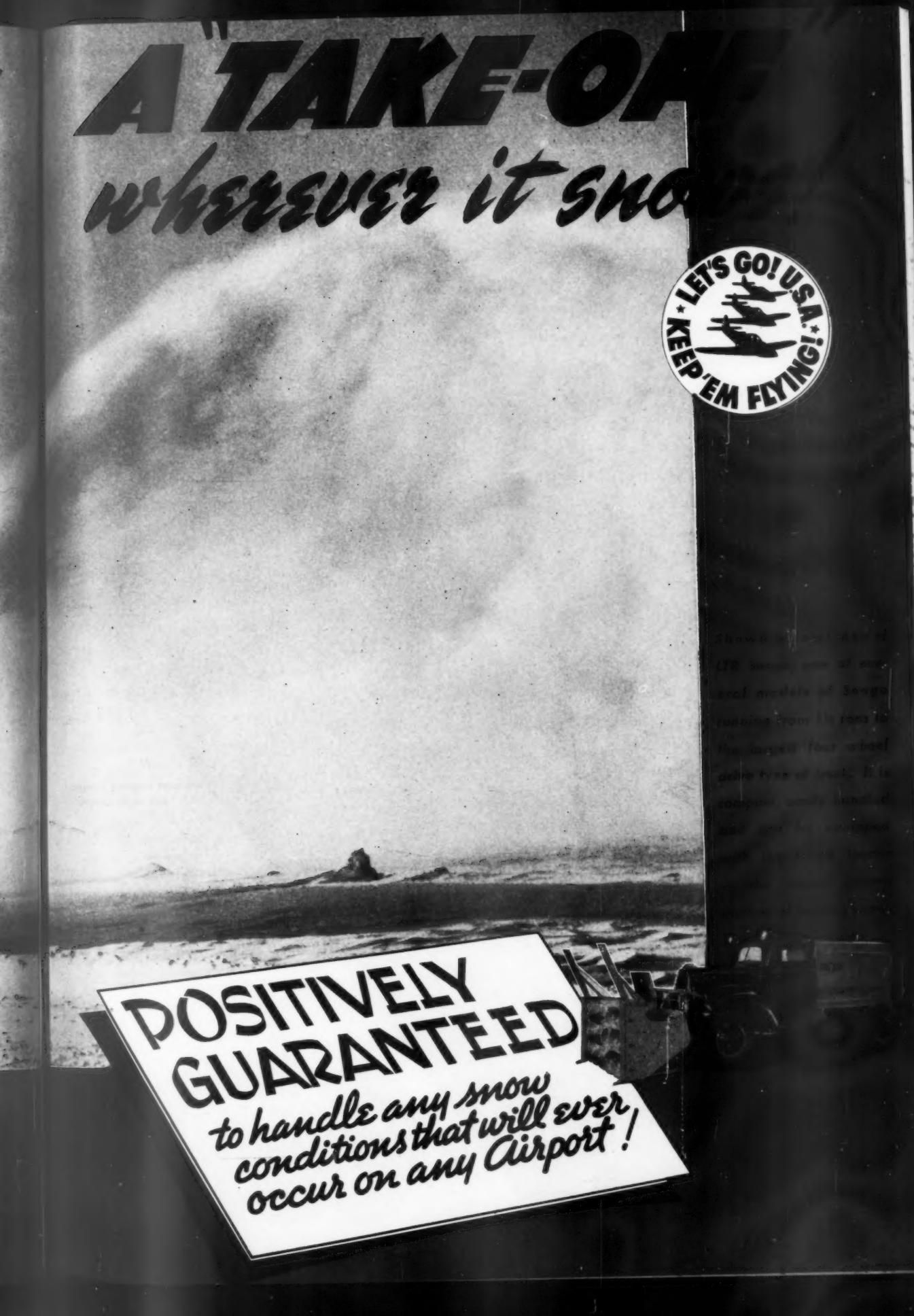
There is no costly rehandling and where the field must be completely cleaned, Snogo is the fastest known method of loading snow.

Where compaction must be used to provide an "allway field" the easy handling of Snogo and its ability to stay up "on top" as compared with heavier more cumbersome machines, means time saved.

There are lessons here to be learned for the future of profitable commercial winter flying. Only one washout pays for a Snogo.

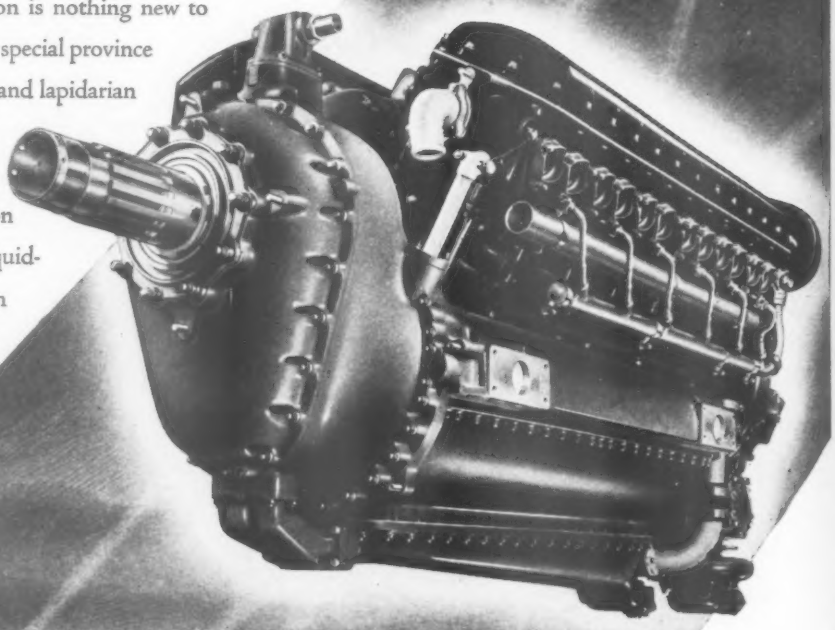
KLAUER MANUFACTURING CO.
Dubuque • Iowa

SNOGO — For Complete Snow Removal


A "TAKE-OF
wherever it sno
LET'S GO! U.S.A.
KEEP 'EM FLYING!
POSITIVELY
GUARANTEED
to handle any snow
conditions that will ever
occur on any Airport!

BRILLIANCE WITH A PURPOSE

Like mirrors and jewels is the sparkle of polished metal parts in an Allison—but the eye cannot begin to see the perfection this brilliance reflects. ★ For one of the challenges in making aircraft engines is this... ★ To preserve—by exquisite accuracy of manufacture and finish—all of the inherent strength and endurance in every ounce of material used. ★ This need for perfection is nothing new to Allison. For years it has been our special province to handle metals with precision and lapidarian skill. ★ In today's tasks we are advantaged by all that General Motors has to offer in production techniques. ★ The result is a liquid-cooled aircraft engine which in performance can speak for itself — and an engine which we are resolved to make the finest in the world.



KEEP AMERICA STRONG
BUY MORE BONDS

POWERED BY
ALLISON

P-38—Lightning
P-39—Airacobra
P-40—Warhawk
P-51—Mustang

LIQUID-COOLED AIRCRAFT ENGINES

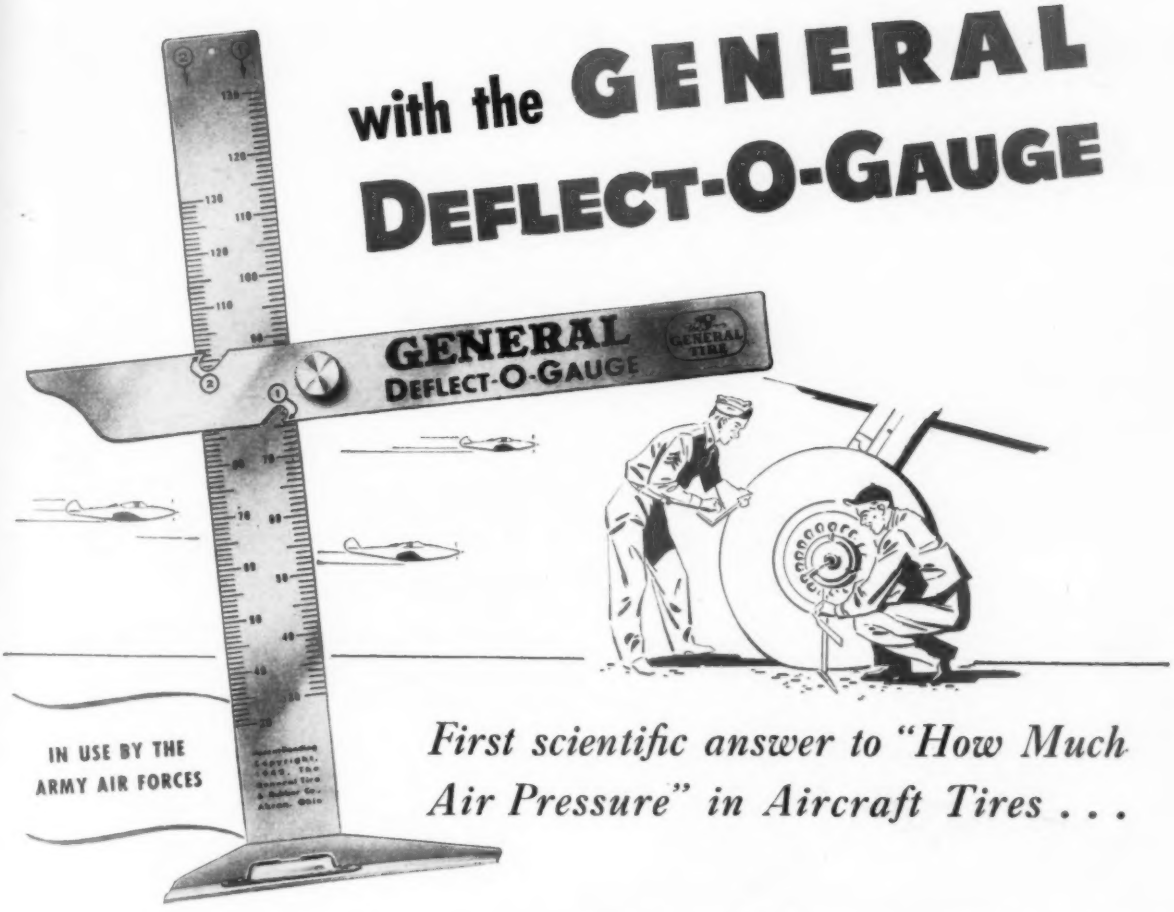
Allison

DIVISION OF

GM
GENERAL
MOTORS

ANOTHER AVIATION "FIRST" FOR GENERAL TIRE . . .

with the GENERAL DEFLECT-O-GAUGE



First scientific answer to "How Much Air Pressure" in Aircraft Tires . . .

● Out of The General Tire & Rubber Company's long, practical experience in the design and manufacture of aircraft tires and other aviation products, comes this new, scientific instrument for designating *correct aircraft tire pressures* . . . regardless of load!

The General Deflect-O-Gauge, developed by aircraft tire engineers, takes up where the ordinary "air-pressure" gauge leaves off! Easy to use . . . but a precision instrument that *measures tire deflection.* Indicates absolutely accurate limits for variable take off loads on all Type I, (Smooth Contour), Type II, (High Pressure), Type III, (Low Pressure), Type IV, (Extra-low Pressure) and Type VI, (Low Profile) aircraft tires of any make, and begins a new era of accuracy in aircraft tire maintenance.

The General Deflect-O-Gauge is made of high quality steel, plated for protection . . . calibrations are easy to read . . . spirit level on base assures correct readings. Comes packed in a sturdy, attractive wooden case, the General Deflect-O-Gauge can be assembled in 10 seconds. For further information, fill out the coupon and mail to Aviation Division, General Tire & Rubber Company, Akron, Ohio.

THE GENERAL TIRE & RUBBER COMPANY
AVIATION DIVISION • AKRON, OHIO

Clip this coupon . . . send for informative instruction booklet for the General DEFLECT-O-GAUGE . . . Address: Aviation Division, The General Tire & Rubber Company, Akron, Ohio.

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Company _____

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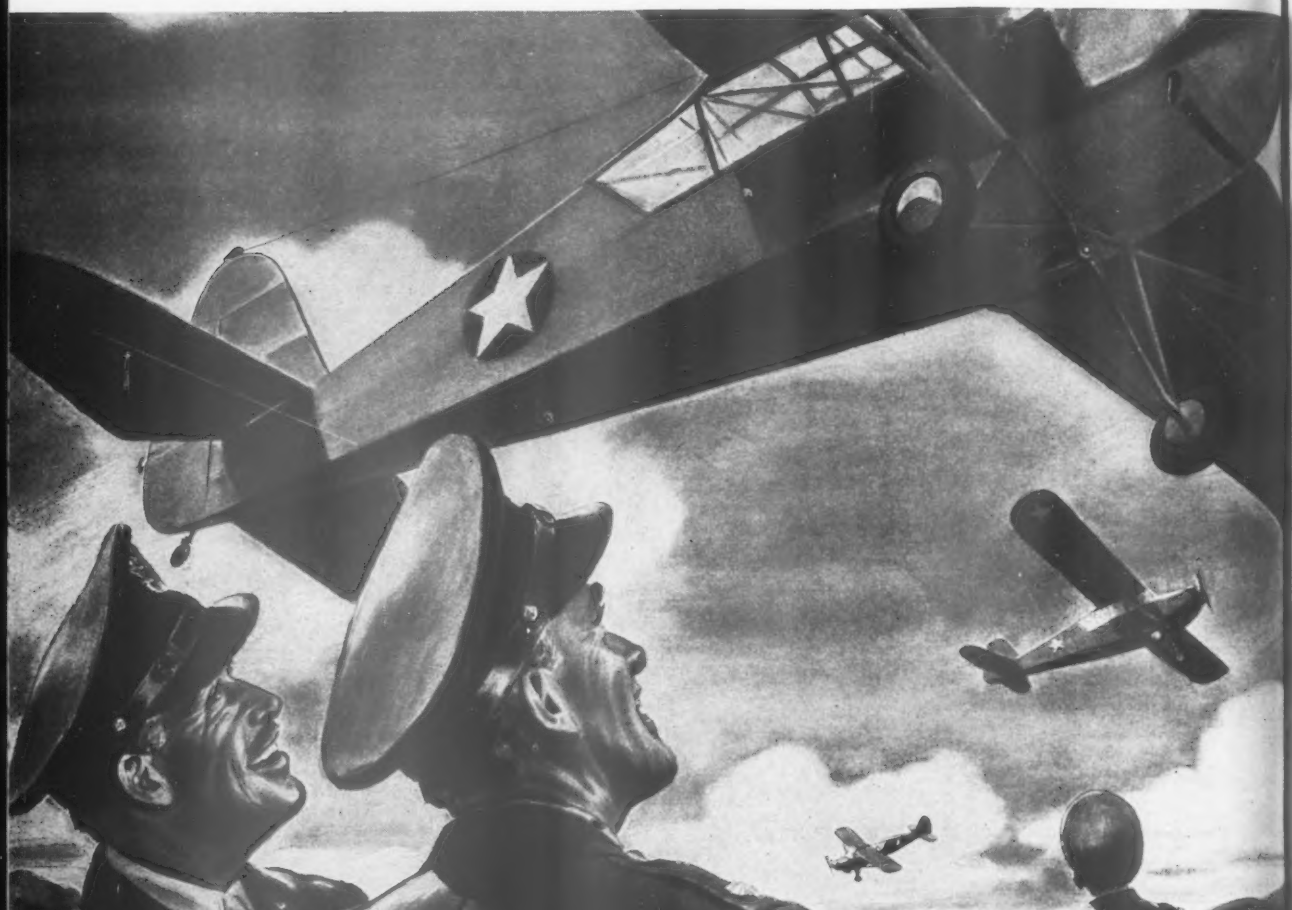
NO CHARGE *Mail this today!* NO OBLIGATION

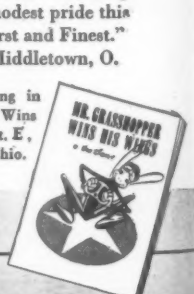
THEY'RE GRASSHOPPERS—B'GAWD!

Abel Grasshopper . . . reporting for duty, sir! Able to climb quickly from restricted space . . . . . able to land anywhere—roads and willing to do any tough chore the Army may assign.



War or Peace . . . when anything new takes place in lightplane progress, expect it to start with Aeronca . . . that's why Grasshoppers were born! ☆ ☆ ☆ Just a short time before America's official entry into the war, the Army decided to experiment with light planes under actual combat conditions . . . take-offs from small, bumpy fields . . . landings in congested areas . . . sometimes a country road . . . often just a common cow pasture . . . all kinds of weather . . . and constant alerts both day and night. ☆ ☆ ☆ And the easily handled Aeroncas came through all gruelling tests with such a record for dependability, that today, satisfied Air Corps Personnel allocate them for pre-glider training, liaison work with troops afield, artillery operations, and various other assignments for which their maneuverability and control qualify them. ☆ ☆ ☆ Officially designated as the Army's L-3-C . . . a keen-minded brass hat, after seeing them perform, promptly dubbed them "Grasshoppers" . . . We emphasize with modest pride this apt appreciation of Aeronca "First and Finest." Aeronca Aircraft Corporation, Middletown, O.

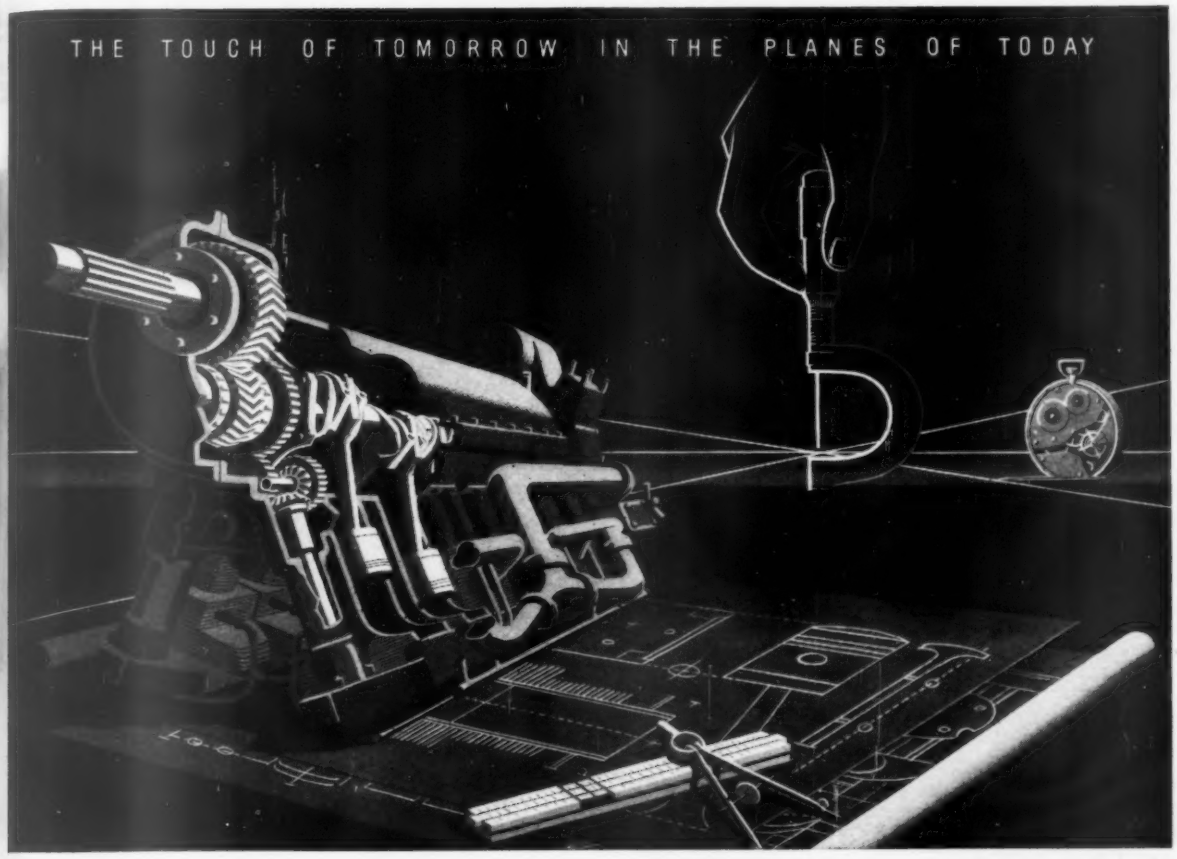
A full-color book to delight the young in heart . . . Walt Disney's "Mr. Grasshopper Wins His Wings". Send 10¢ in stamps to Dept. E, Aeronca Aircraft Corp., Middletown, Ohio.



AERONCA

FIRST *Grasshopper* FINEST

© 1943—Aeronca Aircraft Corporation



How Precise is Precision?

Maybe *your* yardstick is a fine watch. *Ours* is a Ranger 12-cylinder in-line, air-cooled engine. See the comparisons between the two listed below.

A whole battery of fine laboratory instruments, plus the genius of craftsmanship, are responsible for the Ranger's outstanding precision performance.

There's the spectroscope, for example—so sensitive it can spot a particle of metal as minute as seven parts in a hundred thousand. Fairchild uses it to explore and to control the metals in Ranger engines.

A quarter million volt X-Ray is another Fairchild key to secrets that are hidden beneath 4 inches of solid steel. It tells our engineers which metals can "take it."

Under a metallurgical microscope our technicians can read the history of any metal . . . tell how it was processed during manufacture.

With electrical instruments they can detect a flaw one ten-thousandth of an inch in depth that *could* become a bottomless pit of danger.

A beam of black light is played over machined surfaces to expose the structural "criminals" that may lurk within.

These and hundreds of other present-day miracles are routine matters for Ranger engineers and scientists. Result—the Ranger Engine...combination of precision and power . . . another Fairchild "touch of tomorrow in the planes of today."

A QUALITY WATCH	A RANGER ENGINE
PARTS—about 350.	PARTS—exactly 4,127
PRECISION measurements—wheel pivot held to a tolerance of 1/2 of 1 per cent of its diameter.	PRECISION measurements—impeller shaft held to a tolerance of 1/10 of 1 per cent of its diameter.
SPEED of moving parts—balance wheel oscillates 5 times per second.	SPEED of moving parts—fastest part revolves 520 times per second.

BUY U. S. WAR BONDS AND STAMPS

RANGER AIRCRAFT ENGINES

Division of Fairchild Engine and Airplane Corporation • Farmingdale, Long Island

If You Have A Vibration Problem...

Vibration-loosed connections are major sources of trouble on automobiles, bicycles and household appliances as well as on industrial, farm and office machinery. To eliminate such trouble, manufacturers who place a premium on customer satisfaction, will, in the post-war period, use Boots Nuts wherever vibration is a factor. First developed for use on airplanes, where loose connections cannot be tolerated, Boots Self-Locking Nuts withstand severest vibration—they can't come loose.

WHERE RESCUE RIDES ON LIGHTNESS

Lighter than any other nuts, Boots all-metal, self-locking nuts save from 60 to 80 pounds of weight on a single 4-engine bomber. This saving is sufficient to enable that bomber to carry a 7-man rubber life raft with 30 days' emergency rations, signal, repair and first aid kits, oars, rope, sail, scout knife, pistol, fishing tackle, whistle, bailing bucket, sea anchor and tarpaulin. Total weight 70 pounds.

Boots Nuts meet the exacting specifications of all government agencies and are used on every type of U. S. aircraft. They withstand severest plane vibration and the corrosive action of oil, salt water or chemicals. They can be used again and again—literally "outlast the plane."

"They Fly With Their Boots on—*Lighter*"

BOOTS

Self-Locking Nuts For Application In All Industries

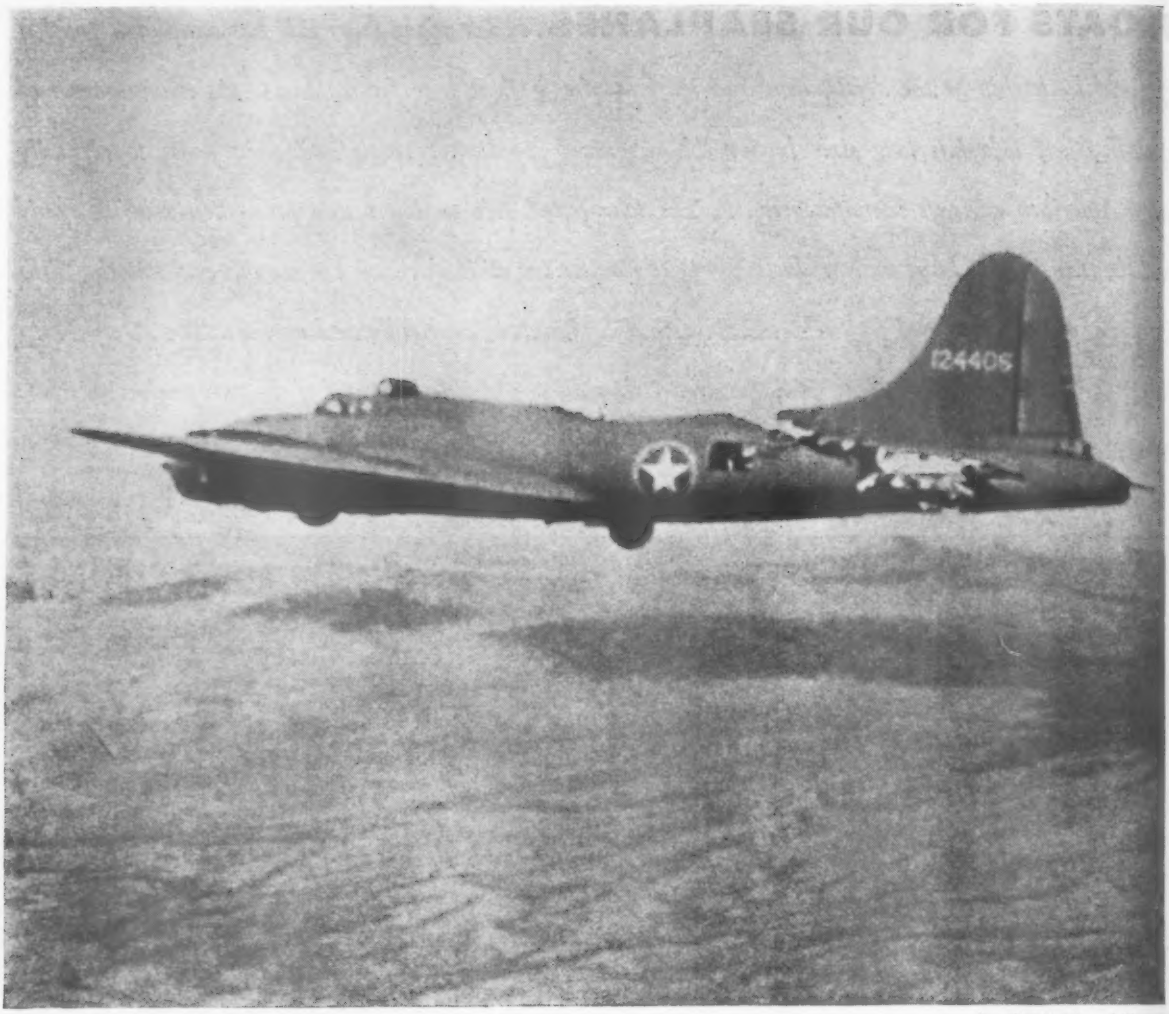
BOOTS AIRCRAFT NUT CORPORATION ★ GENERAL OFFICES, NEW CANAAN, CONNECTICUT

FLOATS FOR OUR SEAPLANES... *For many years Edo has occupied a position of world leadership in the development and manufacture of float gear for seaplanes. As a consequence of specialization, Edo has long since become the recognized supplier of single and twin floats to virtually every American aircraft manufacturer . . . The war found Edo engineers and production methods ready and the transition to large scale production of float gear for our military aircraft was swift and smooth. With the aid of greatly increased facilities, exacting schedules have been met fully and on time. The Army-Navy "E," flying over the Edo plants, is an assurance that all is well on this sector of the vast production front.*

EDO AIRCRAFT CORPORATION, 414 SECOND STREET, COLLEGE POINT, L. I., N. Y.

EDO FLOAT GEAR

SERVES THE UNITED NATIONS



Buy War Bonds and Stamps

No Achilles Heel

This slashed-in-two Flying Fortress* theoretically should not fly. There had been stiff fighter opposition. In the melee, a Messerschmitt, crazily out of control, crashed into it.

The German plane was destroyed on impact. The Fortress' fuselage was ripped diagonally from top to bottom. Control surfaces were carried away. The tail gunner, suddenly imperiled in his wabbling section, crawled forward over the narrow floor structure that held the parts together. And the Fortress flew steadily for an hour and three-quarters —back to her base for a perfect landing!

Often the question is asked about Boeing Fortresses: *"How can they do it?"* One Fortress came home with 2000 bullet holes, and with big areas of both wing sections shot away. Another had a hole in the fin "large enough for the navigator to walk through." Others have come in with rudder and elevator controls sheared by gunfire.

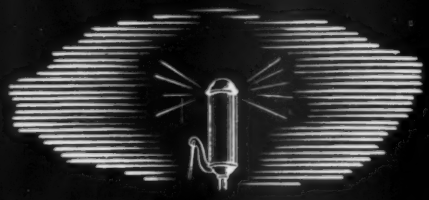
How can they do it?

One reason is Boeing design. The Fortress has no Achilles heel, no highly vulnerable spot for the enemy to attack. No single structural member has to carry the entire load for its section; even when large portions of the plane are badly damaged, the Fortress usually is strong enough to remain aloft, fight off its enemies, and return home.

There are other reasons, of course — many of them. But they all stem from what has been termed the integrity of Boeing products. Soundly and conservatively engineered, honestly built, these products always have done more than has been expected of them. True today, it likewise will be true in peacetime tomorrow . . . if it's "Built by Boeing" it's bound to be good.

DESIGNERS OF THE FLYING FORTRESS • THE STRATOLINER • PAN AMERICAN CLIPPERS **BOEING**

*THE TERMS "FLYING FORTRESS" AND "STRATOLINER" ARE REGISTERED BOEING TRADE-MARKS



Dare We Speak of Peace?

Yes—because it means so much to all of us individually. With it will come again those products of industry like the car, the radio and the refrigerator, which never were luxuries so much as necessities. And those who are thinking in post-war terms are asked to remember that Weatherhead will be prepared to help build these products again as well as the many strange new ones destined to emerge from this war.

Look Ahead with

Weatherhead

THE WEATHERHEAD COMPANY, CLEVELAND, OHIO
Manufacturers of vital parts for the automotive, aviation, refrigeration and other key industries.

Plants: Cleveland, Columbia City, Ind., Los Angeles
Canada—St. Thomas, Ontario

Republic Aviation Thunderbolt

...when a *Thunderbolt* lands

Considered the fastest and most powerful high-altitude fighter in the sky today, the Republic P-47 Thunderbolt relies upon time-tested Houdaille hydraulic mechanism to raise or lower its rugged landing gear and to operate its wing flaps.

Behind Houdaille products is more than a quarter-century of engineering experience which today is producing equipment *in quantity* for many types of war planes, from the highest speed fighters to the heaviest bombers.

THE HOUDAILLE-HERSHEY CORPORATION
Detroit, Michigan

BUFFALO ARMS CORPORATION
Buffalo, N. Y.

GENERAL SPRING BUMPER DIVISION
Detroit, Mich., and Chicago, Ill.

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MUSKEGON MOTOR SPECIALTIES CO.
Muskegon, Mich.

OAKES PRODUCTS DIVISION
North Chicago, Ill., and Decatur, Ill.

SKINNER COMPANY, Ltd.
Oshawa, Ontario, Canada

CHAMPION SPARK PLUGS

in today's high output, turbo supercharged engines take a lot of punishment. The same qualities that made Champion the spark plug of racing champions have skyrocketed them to favor for our most powerful aircraft engines.

C26S—Shielded

C26—Unshielded

Just as no chain is stronger than its weakest link, so no spark plug is better than its insulator.

The insulating material used in Champion Ceramic Aircraft Spark Plugs is a revolutionary, new development, having properties and advantages unequalled by any other insulating material.

Its resistance to heat and mechanical shock—wide variation in temperature and pressures—make it ideally adapted to the manifold ignition problems encountered in high altitude flight.

In addition, Champion Ceramic Aircraft Spark Plugs are backed by thirty-odd years of experience in the spark plug field exclusively—a certain "know how" that is evidenced by their outstanding dependability with our air forces.

Characteristic advantages of Champion Ceramic insulation are:

1. Immunity from heat and chemical reactions.
2. Freedom from fuel, oil, or moisture absorption which causes "shorts".
3. Inherently high heat conductivity with consequent wider range between pre-ignition and fouling.
4. Absolute uniformity of material.
5. Homogeneous structure eliminates air spaces which cause current leakage.
6. Easily cleaned and serviced—no specialized equipment or factory returns necessary.
7. Scientifically controlled manufacture.

USE CHAMPIONS AND FLY WITH CONFIDENCE

This advertisement is one of a series which will appear in national magazines and newspapers this year as Consolidated's contribution toward a clearer public understanding of "aviation geography."

This Soviet worker in Yakutsk, Siberia, lives only 18 hours flying time from the Washington, D. C. airport.

It's 37 hours' flying time from Kansas City to this Chinese student's home, outside Chungking.

The office of this newspaper publisher in Calcutta, India, is 43 hours' flying time from Times Square, N. Y.

This Alaskan Eskimo lives near Fairbanks—13 hours' flying time from the Chicago airport.

A 23-hour flight from Boston will put you in the office of this wholesale coffee dealer in Sao Paulo, Brazil.

The Pacific atoll where this Fiji Islander lives is only 34 hours' flying time from Denver.

No man on earth lives more than 60 hours from your local airport...

"A LOT OF THINGS are different in India than they are back home in Altoona," wrote a 19-year old sergeant in the U. S. Air Forces to his mother in Pennsylvania.

Never before in his life had this boy travelled beyond Pittsburgh — until he flew to India in a Liberator bomber.

To him — and hundreds of thousands of home-town American boys like him — India was a place "off there somewhere." He'd seen it in the newsreels and travelogue films. In his geography book he'd learned something about India's crops and minerals and untold riches, and the funny way the people dressed.

The world as it really is

Now his letters from overseas — telling how people talk and work and live in a strange land he never dreamed he'd see — *are penetrating into the lives and thinking of his family and friends in the town where he grew up.*

This is happening all over America today And when our boys come home again — from India and China and Britain and Dutch Harbor and Australia and North Africa — they'll think of the world as they know it *really is.*

Not as isolated continents or separate hemispheres, but a clustering of nations whose *individual* welfare, in the peace to come, will depend upon the welfare of them *all.*

They know it can't be otherwise, when *no spot on earth is more than 60 hours' flying time from your local airport!*

In such a world, right now, we face

CONSOLIDATED VULTEE AIRCRAFT

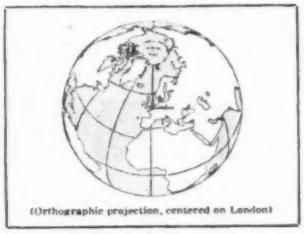
Your sales manager in Brisbane can attend a meeting in San Francisco on short notice. Flying time: 35 hours.

the necessity of waging and winning a global war. Tomorrow — in a world shrunk still smaller because of even swifter long-range planes to come — we and all other nations must somehow contrive to get along together as neighbors.

Air power — for peace

There are bewildering problems ahead. But one thing is certain. The plane — by accelerating the interchange of men, mail, merchandise, ideas, culture, and beliefs — will help to bring about a greater understanding between the peoples of the earth.

And without understanding, there can be no lasting peace.



(Orthographic projection, centered on London)

A plane recently *flew the 1400 air miles from London to Moscow on a special mission in the morning, returning that same afternoon. Top speed: 400 M.P.H.*

(Polar azimuthal equidistant projection)

Today's planes, *with their tremendous speed and long flying range, need not follow old established trade routes. The 9400-mile sea route from New York to Bombay is about a 3-week voyage, but the air route is only 7790 miles. Flying time: 39 hours or less.*

QUICK FACTS FOR AIR-MINDED READERS

Consolidated Vultee designed and perfected the long-range Liberator bomber — was the first to turn out multi-ton bombers in volume production on a moving assembly line.

• • •

Because teamwork means more bombers and an earlier victory, the Consolidated-designed Liberator is also being produced by Ford, Douglas, and North American.

• • •

Liberators and Catalinas have helped to provide a "complete shore-to-shore air cover" spanning the Atlantic as protection for convoys against Nazi submarines, according to joint statement by British Admiralty and Air Ministry.

• • •

All transport planes, including the Liberator Express, are being equipped to carry standard stretchers for the evacuation of wounded, according to the Office of War Information.

• • •

To protect Australia's 11,000-mile coastline, the Royal Australian Air Force chose Catalinas as ships that can regard "journeys of 2000 miles or more as routine. Catalinas can remain in the air for thirty hours and can reach Australia's remotest bases and return without refueling," according to the Commonwealth of Australia Department of Information.

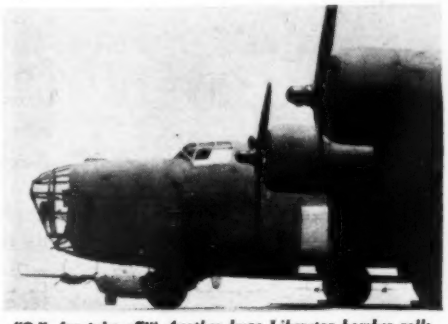
• • •

At the end of 1943, the United States will have about 865 airports, each with paved runways of 3500 feet or more. This compares with less than 100 such airports in 1940.

• • •

There are 11 Consolidated Vultee plants in the United States. If these 11 plants could be put under a single roof, they would occupy a building 3 miles long and 5 city blocks wide.

In addition *to the Liberator bomber, Liberator Express transport plane, and the Coronado and Catalina patrol bombers, Consolidated Vultee also builds dive bombers, trainers, and torpedo planes.* Above: *the Valiant — basic trainer widely used by the Army, Navy, and Marine Corps.*



"O.K. for take-off!" *Another huge Liberator bomber rolls off Consolidated Vultee's moving assembly lines into the hands of the test pilots. On every aerial battle front, the speed, range, fire power, and precision bombing of the 4-engine Liberator is helping to transfer the Axis dream of victory into a nightmare.*

CONSOLIDATED VULTEE AIRCRAFT CORPORATION

San Diego, Calif. • Vultee Field, Calif. • Fort Worth, Texas
New Orleans, La. • Nashville, Tenn. • Wayne, Mich.
Allentown, Pa. • Tucson, Ariz. • Elizabeth City, N. C.
Louisville, Ky. • Miami, Fla.

Member, Aircraft War Production Council

LIBERATOR (4-engine bomber) — CORONADO, CATALINA, (patrol bombers) — P4Y (anti-submarine plane) — LIBERATOR EXPRESS (transport) — VALIANT (basic trainer) — VENGEANCE (dive bomber) — SENTINEL ("Flying Jeep") — RELIANT (navigational trainer)

Charge of a "COMMANDO"

Giant transport takes off on *AEROLS**

Capable of carrying jeeps and light artillery, as well as paratroops, Curtiss-Wright's "Commandos", used by the Army Air Force, are destined for a vital role in today's lightning warfare.

Equipped with Aerols, these huge, heavily laden transport planes sweep away to swift, sure take-offs. And their landings are feather light, for Aerols effectively cushion all landing shocks.

Today, Aerols are providing performance of this quality not only on "Commandos", but on *every* type of military aircraft. Such service forecasts their importance to the future safety and comfort of travel by air.

THE CLEVELAND PNEUMATIC TOOL COMPANY
AIRCRAFT DIVISION • • **CLEVELAND, OHIO**

Also Manufacturers of **Cleco pneumatic tools for the aircraft and general industry, Cleco sheetholders, Cle-Air shock absorbers for trucks and buses, and Cleveland rock drills for mining and construction work.**

AEROLS*

*THE SHOCK ABSORBING UNITS ON AN AIRPLANE'S LANDING GEAR; THE NAME IS DERIVED FROM THE WORDS "AIR" AND "OIL"—THE FLUIDS USED TO DISSIPATE THE LANDING SHOCKS

"SEEING" through Fog and Darkness

RADIOMEN OF "THE INVISIBLE CREW"

These "Radiomen" have the ability to withstand extreme service conditions due to the painstaking efforts of Bendix Radio Engineers. No detail is too small to escape the grueling tests that insure unfailing performance. Electronic research continually steps up already high performance to exceed every standard previously reached.

BENDIX RADIO

Superhuman Vision with "THE INVISIBLE CREW"

Superhuman range, far into space . . . superhuman penetration, through darkness, cloud or fog . . . this is the electronic "vision" that Bendix Radio developments give to the pilot of U. S. combat aircraft.

With special electronic devices developed by Bendix Radio, he "sees" what lies ahead. He talks with fellow pilots, and keeps in touch with comrades on the ground. He picks up distant radio stations to guide him on his course.

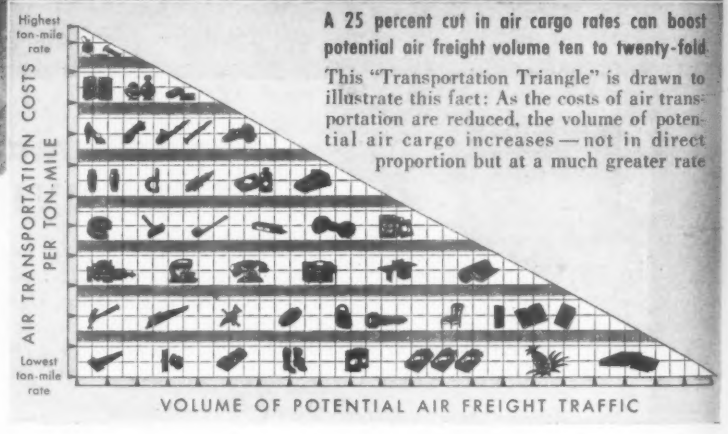
Daily, as routine practice, he uses new and wondrous electronic applications of Bendix Radio too confidential to talk about now. Through these members of "The Invisible Crew" he senses secrets of the future . . . the future that awaits his triumphant return.

More than 25 Bendix plants are speeding "The Invisible Crew" to world battle fronts.

THE INVISIBLE CREW
Precision Equipment by
Bendix
AVIATION CORPORATION

BENDIX RADIO DIVISION

PREDICTION: Postwar freight will fly ... at less than 15 cents a ton-mile


Highest ton-mile rate
AIR TRANSPORTATION COSTS PER TON-MILE
Lowest ton-mile rate
VOLUME OF POTENTIAL AIR FREIGHT TRAFFIC

A 25 percent cut in air cargo rates can boost potential air freight volume ten to twenty-fold.

This "Transportation Triangle" is drawn to illustrate this fact: As the costs of air transportation are reduced, the volume of potential air cargo increases — not in direct proportion but at a much greater rate.

AFTER VICTORY looms one certainty: Out of America's war-accelerated research will come new and different airplanes for a world at peace.

Airplanes so advanced as to make obsolete the newest and largest transports in the skies today.

Planes of new, unorthodox design—capable of carrying larger loads longer distances with greater economy in operating costs.

Giant land and seaplanes. "Shuttle" craft for short hauls. Express planes of incredible speed.

In these airplanes America's postwar products and American technicians will have the means to go fast and far to markets anywhere on earth—to unlock the world's commerce—and create new horizons for the better material welfare of us all.

Knowledge U. S. aircraft designers already possess is enough to guarantee this prophecy. For aircraft now on drawing boards can be operated profitably at rates below 15 cents per ton-mile. The rates for air freight before the war were from 80 to 90 cents per ton-mile!

With the coming of victory, Northrop accomplishments, together with those of other U. S. leaders, will contribute to a new world of peace and opportunity. A more desirable world in which to live.

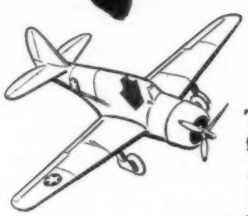
Meanwhile all the resources of Northrop in plane design and plane construction are devoted solely to producing the planes of war. The planes that bring closer the day of complete victory for the Allies.

NORTHROP *Aircraft, Inc.*

NORTHROP FIELD, HAWTHORNE, CALIFORNIA

MEMBER AIRCRAFT WAR PRODUCTION COUNCIL, INC.

Armor Plate



ARMORED PROTECTION AGAINST THE ENEMY

The pilots and gunners of America's hard-hitting fighting aircraft rely on the protection of Breeze Aircraft Armor Plate to help "bring 'em back alive". Light in weight, this Armor Plate is engineered in a wide range of special shapes and sizes to meet designers' requirements.

Produced by the Breeze Electric Heat-Treating Process, the fastest known for this purpose, Breeze Armor is standard on American fighters and bombers. Today, Aircraft Armor Plate supplements the many other well-known items of Breeze equipment which are being produced in ever-increasing quantities for the fighting forces of the United Nations.

BREEZE CORPORATIONS, INC., NEWARK, N. J.

Breeze

BREEZE MARK

FOREWORD

IN THIS report to the Nation is presented the first well-rounded and authoritative account of the *United States Army Air Forces at War.*

It is a record of achievement, of brilliant American science, skill and know-how, of a great and resourceful leadership. But more, it is tribute to those enduring qualities of mind and soul which have always in crisis made our country great.

The inner significance of this remarkable story is this: that a nation, accustomed to an era of plenty and devoted to the ways of peace, possessing little more than a token military establishment, has been able to create, virtually out of nothing and within the short span of 18 months, the most formidable assault force modern military technology has ever conceived. During this brief period it not only trained this great task force but equipped it with modern instruments of attack greatly superior to those held by a supposedly invincible enemy; and was able to move these machines and men together with their auxiliaries and equipment to all the major theaters of the globe.

The spearhead of the triumphant operations now taking place all over the world is the U.S. Army Air Forces. Eighteen months ago a rapidly growing but still minor auxiliary, the Air Forces are now the pride and glory of our entire military establishment, the most powerful single military body in existence, capable of forcing its own decisions as well as of loyal cooperation with the other arms of American military might.

Nowhere in history has an inexperienced people, rising by their own bootstraps in war, created so quickly and on such a massive scale so magnificent a military arm as this. I venture to predict that for this fact alone it will live in the traditions of mankind long after most areas of achievement in this bloody conflict have been lost to memory.

No one can now deny that the American military air establishment, together with its brothers of the U.S. Naval air arm and the Royal Air Force, has been the savior of our civilization. In the little modest group of men who were responsible for the creation of that modern whiplash of Mars, the U.S. Army Air Forces, history will see a knightliness and glory unsurpassed in the military annals of nations anywhere. Without them and their sky battleships this war, if it were won at all, would be resolved after a struggle so long, so bitter and so costly as to leave our civilization in an endless agony of exhaustion.

To that great war machine, symbol and instrument of the indomitable American spirit, the U.S. Army Air Forces, I make a humble salute in which all Americans who read the pages which follow will join me.

To Gen. H. H. Arnold, Maj. Gen. George E. Stratemeyer, the Hon. Robert A. Lovett, to members of the Air Staff and other military personnel under whose direction this material was prepared, I make grateful acknowledgement.

William B. Ziff

Editor and Publisher, FLYING

AAF ON THE OFFENSIVE

By

HON. ROBERT A. LOVETT

Assistant Secretary of War for Air

IN this issue of FLYING a portion of the brief but brilliant history of the Army Air Forces is recorded. From it the reader can obtain some idea of its initial problems, their gradual solution, the steady technical improvement, the recognition of the Air Forces as an offensive arm, and its meteoric ascendancy and expansion to meet the strategic, tactical and supply requirements of a war around the world.

We still have a long way to go. But we know where we are going. Every man in the Army Air Forces knows that our goal is to develop the finest air force in the world—the finest in quality of personnel and equipment, in striking power and in balance. Every man knows that tougher jobs lie ahead and that in doing them complete victory is brought nearer.

Public interest, and even history itself, tends to focus its attention on the dramatic highlights of this air war—Midway, Bismarck Sea, Tunisia, Pantelleria, Sicily and the bombing of German bases and industry. But to the men of the Army Air Forces the record of accomplishment is measured more by the successful completion of the routine jobs, where each member of the team must do his part.

On the faithful performance of the less glamorous tasks depends the operating efficiency of the Air Forces—the loyal, tireless ground crews; the shuttle services from the West Coast to Australia and from the East Coast across the North and South Atlantic; the supply route over the Himalayas into China; the service crews in lonely fields in the African desert and in tropical jungles; the fog flight to Kiska; the training of thousands of air crews a month and of equal thousands of ground crews. These are the daily chores on which success depends. These are the jobs that must be done and that are done with a selfless sense of duty that is an inspiration to the whole Air Force.

If the reader wishes to obtain a true picture of the Army Air Forces he should keep constantly in mind the fact that spectacular successes are based on the successful performance of unspectacular duties. We are proving every day that team work, imaginative leadership and plain, hard work are the safest foundations on which to build for the future which the Army Air Forces face with eagerness and with confidence.

AIR STRATEGY FOR VICTORY

By

GENERAL HENRY H. ARNOLD

STRATEGY is the art of war and is concerned with the ability to concentrate military force on the enemy at a given time and place. Air strategy involves all the methods by which a nation impresses its will through the use of air power. It concerns the selection of the enemy targets and the best means of their destruction from the air.

Strategy is as old as history and its general principles have changed but little down through the centuries. Air strategy, however, is as new as the long-range heavy bomber, with its ability to span oceans and continents with loads of destruction.

America's air doctrine for years has been based solidly on the principle of long-range bombardment. Air forces are strictly offensive in character. This was not generally appreciated until recently, and efforts to gear our Air Force solely to defense or to limit it strictly to co-operation with ground forces were bound to fall short of our requirements.

No longer are broad oceans or "Maginot Lines" regarded as sufficient protection. *War has become global.* Statesmen as well as generals and admirals have been forced to study globes as well as maps, and many radical readjustments in thinking have resulted. Air power has shrunk distances so that we no longer speak of a place as so many thousands of miles away, but so many hours.

Modern war is three-dimensional. No longer are armies and navies to be regarded as effective means of preventing enemy incursions. *War has become vertical.* We are demonstrating daily that it is possible to descend from the skies into any part of the interior of an enemy nation and destroy its power to continue the conflict. War industries, communications, power installations and supply lines are being blasted by attacks from the air. Fighting forces have been isolated, their defenses shattered and sufficient pressure brought by air power alone to force their surrender. Constant pounding from the air is breaking the will of the Axis to carry on.

The days when a nation depended wholly on its army and navy for victory have gone forever. *War has become total.* Air power brings the reality of war to the people as a whole. The laboratory and the factory, the mine and the field—all the nation's resources must be mobilized. There will be no permanent victory in the air or on land or sea without victory on the home front and that means that the enemy home front is a part of our legitimate target for air power. And the air strategy which brings victory must not be scrapped when the last bomb is dropped. For the security of a world in which the air will be a dominating factor our wings must not be clipped.

There are three principal ways in which air power can be used—strategically, tactically and logically. These three aspects of air power stem back into the roots of American air thinking.

Strategic air power is a war-winning weapon in its own right, and is capable of striking decisive blows far behind the battle line, thereby destroying the enemy's capacity to wage war. The highest development of strategic air power in the war to date is found in the activities of the Royal Air Force Bomber Command, our 8th Air Force Bomber Command (now called Strategic Air Force), and Major General Doolittle's Strategic Air Force, one of the component parts of the Northwest African Air Forces, commanded by Lieutenant General Spaatz.

People are only now realizing what a vital part strategic bombing played in the earlier part of the African campaign. All through the summer of 1942, General Brereton's *Mitchells* and *Liberators* and RAF *Wellingtons* and *Halifaxes* were smashing Axis docks and shipping at Tobruk and Bengasi, and ports in Crete and Greece. More than two-thirds of the shipping laden with supplies for the Afrika Korps was sunk, and large numbers of Junkers Ju-52 transports shot down. Rommel's heavy supply line was dried up by long-range air attack.

In the Tunisian campaign this operation was repeated on a grand scale by Major General Doolittle's Strategic Air Force and other elements of RAF Air Marshal Tedder's Mediterranean Air Command. By blasting away at airdromes, ports and shipping and shooting large numbers of air transport planes and huge powered gliders out of the air in some of the most dramatic actions of the war, we were able to isolate the Axis forces and effectively prevent their being reinforced with troops, supplies and equipment.

Strategic air power based in England played an important, although indirect, part in the battle for Tunisia by crippling or destroying war plants in Germany and occupied France. Production of new machine tools, antiaircraft guns, motor transport, aircraft, engines and tanks was slowed down and their flow to the front further reduced by disrupting railroad yards, blasting bridges, blowing up locomotives and freight trains.

Deprived of the weapons of war, the Axis forces collapsed as soon as the terrific drive on the battlefield, by co-ordinated ground and air forces, really got under way. Thousands of lives were saved, and weeks of time, as compared with the mile by mile, village by village method of classical warfare, which has always proved so costly in a war of position. By this action we again proved the sky road to both Berlin and Tokyo can be utilized to the full to blast the heart out of the citadel before our combined operations take over for the final drive.

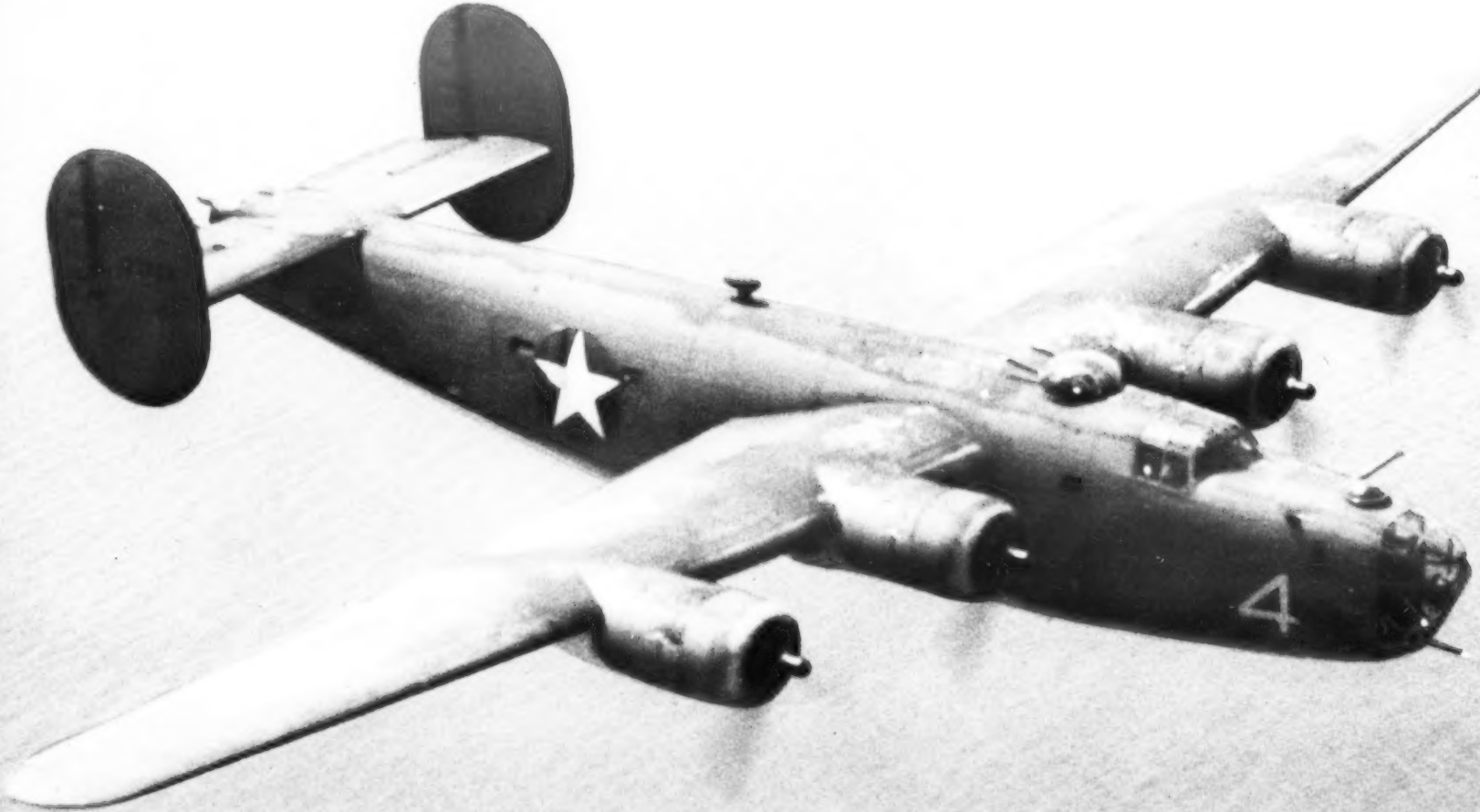
The Army Air Forces' principle of precision bombing, aimed at knocking out not an entire industrial area, nor even a whole factory, but the most vital parts of Germany's war machine, such as the power plants and machine shops of particular factories, has had many illustrations during the past few months. The mission against the submarine works at Vegesack in March was a notable example of precision bombing. With their eyes on the targets, and using an automatic device enabling them

(*Continued on page* 352)

General HENRY H. ARNOLD

Commanding General, United States Army Air Forces

LATEST MODIFICATION OF BOEING FLYING FORTRESS NOW HAS TWO EXTERNAL BOMB RACKS.



CONSOLIDATED LIBERATOR, FIGHTING ON EVERY FRONT, IS BEING SUPPLIED IN LARGE NUMBERS.

WORLD'S FASTEST MEDIUM BOMBER IS THE MARTIN MARAUDER. NOTE TURRET UNDER FUSELAGE.

ONE OF THE MOST SUCCESSFUL OF THE WAR'S VETERANS IS THE NORTH AMERICAN MITCHELL.

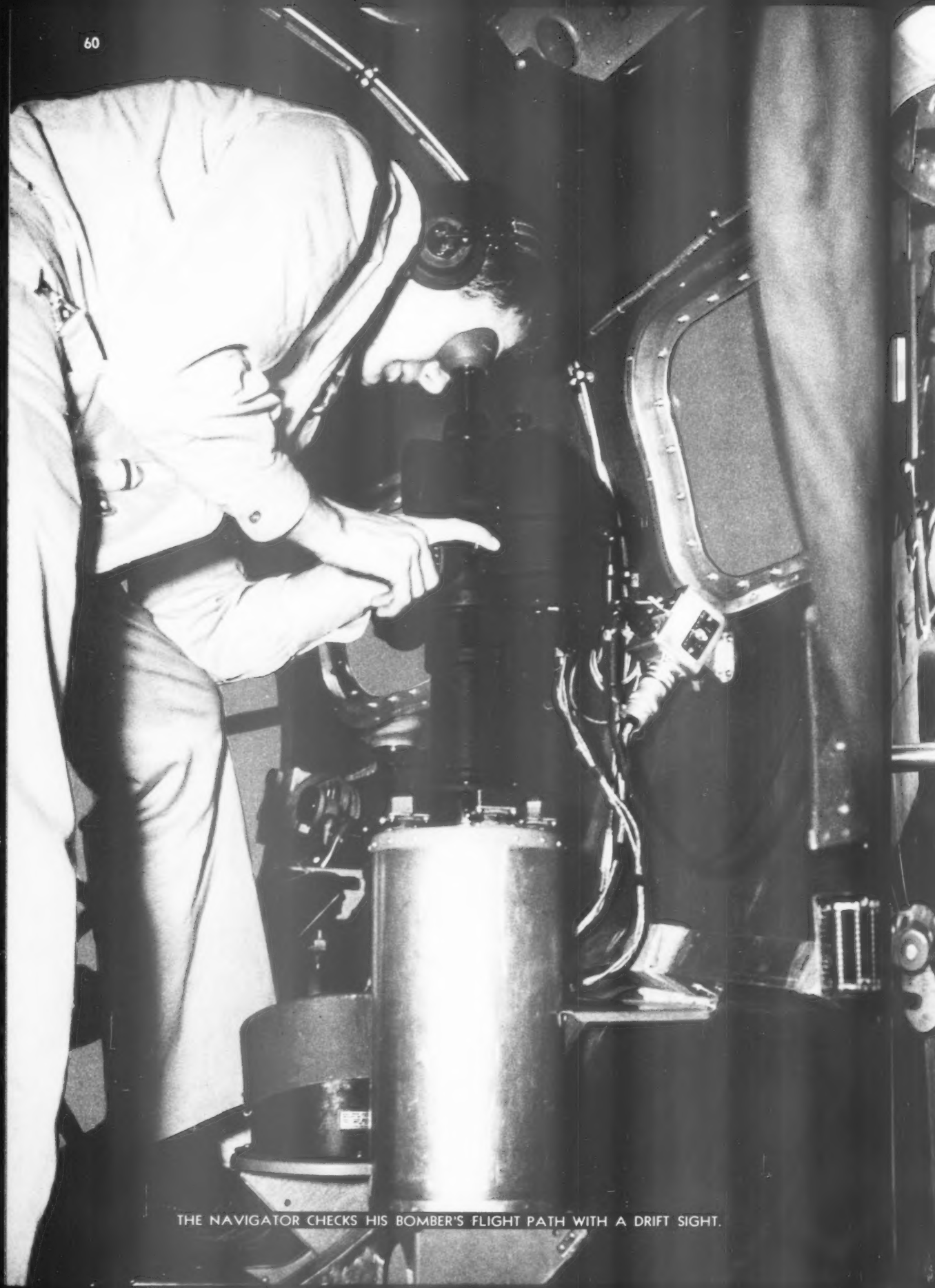
RARELY PUBLICIZED, THE BOMBER MECHANIC HAS A GREAT ROLE IN HITTING THE ENEMY.

THESE AAF ARMORERS KEEP THE FORTRESSES' .50 CALIBER GUNS IN FIGHTING TRIM.

57

CURRENT AAF NIGHT FIGHTER IS FOUR-CANNON DOUGLAS P-70.

ONE OF THE BEST-LIKED AAF COMBAT TYPES IS THE DOUGLAS HAVOC (A-20).



THE NAVIGATOR CHECKS HIS BOMBER'S FLIGHT PATH WITH A DRIFT SIGHT.

MAPPING AND PHOTO RECONNAISSANCE ARE DONE WITH THIS CAMERA.

ONE OF A LIBERATOR'S .50 CALIBER WAIST GUNS.

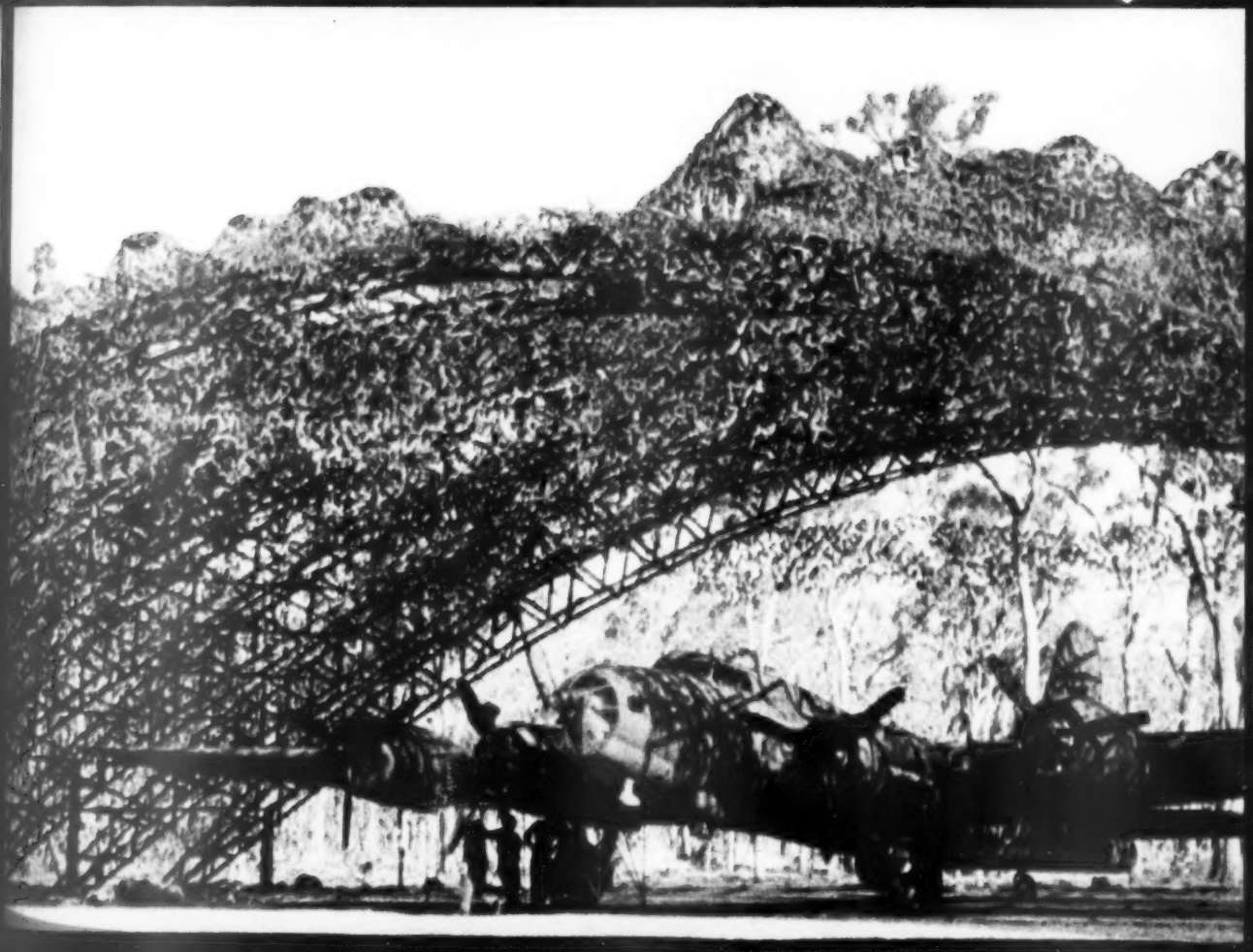
TWIN FIFTIES PROTECT THE TAIL OF THE MARAUDER.

Jap shipping and bases in the Aleutians get special attention from these Liberators. Note unusually good weather.

Crew of one of the Libs above is briefed by its pilot. The objective is on Kiska; pilot is showing approach to target.

As in nearly every other war theater, Douglas Havoc is in wide use in Australia. This one raids nearby Jap bases.

One of earlier Flying Fortresses (a B-17E) in Australia. It is in a camouflaged dispersal hangar, open at front and rear.



LOCKHEED LIGHTNINGS IN AFRICA DID EXCELLENT SKIP-BOMBING WITH BOMBS THIS SIZE.

Beechcrafts at Work

Beechcraft AT-11 Bombing Trainers on the Line
OFFICIAL PHOTOGRAPH U. S. ARMY AIR FORCES

Beech Airc

BEECHCRAFTS ARE DOING THE

Aircraf

RE DOING THEIR PART

THE AT-11 BEECHCRAFT bombing trainers shown ere at work help provide the world's most thorough bombardier aining for members of the U. S. Army Air Forces. These planes are nly one of six specialized adaptations of former commercial Beechraft models now serving the Air Forces and the Navy Bureau of Aeronautics. In Beechcrafts, pilots, navigators, bombardiers, and aerial hotographers perfect their skills; command personnel finds swift, omfortable transportation; and many special-purpose and utility issions are performed. ★ All of the specialized military Beechcrafts etain the proven performance qualities of their commercial prototypes . . high cruising speeds combined with low landing speeds, stability, fficiency and great sturdiness. ★ The good use which our armed services are making of this equipment is obvious from the box scores of erial combat, in which enemy losses greatly and consistently outnumber our own losses . . . a direct result of the superior training which ur airmen receive as members of the world's finest air services.

ft

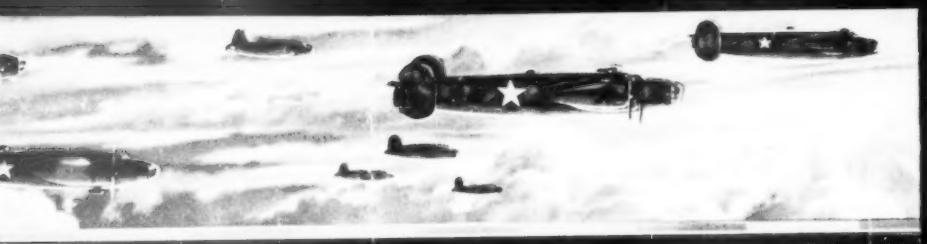
BEECH AIRCRAFT CORPORATION

WICHITA, KANSAS, U. S. A.

RT

Reprints of this Photograph, without advertising, suitable for framing, can be obtained from the Beech Aircraft Corporation.

ARMY AIR FOR
AUSTRALIA
DARWIN
SYDNEY
AUCKLAND
PACIFIC
OCEAN
PACIFIC
ASIA
NORTH POLE
N. AMER.
ATLANTIC OCEAN
AFRICA
INDIAN
Phil Santry
TAD



ORCES MAP OF T

SINGAPORE
RANGOON
BOMBAY
CALCUTTA
CHUNGKING
SHANGHAI
ASIA
SUEZ
MOSCOW
TOKYO
BERLIN
ROME
LONDON
GIB
NORTH POLE
GREENLAND
HOME
ALASKA
CANADA
ATL
UNITED STATES
WASHINGTON
SOU
AMER
PANAMA

MAP OF THE WORLD

NGOON
BOMBAY
CALCUTTA
ASIA
AFRICA
CAPETOWN
SUEZ
MOSCOW
BERLIN
ROME
LONDON
GIBRALTAR
NORTH POLE
GREENLAND
ATLANTIC OCEAN
CANADA
UNITED STATES
WASHINGTON
SOUTH AMERICA
PANAMA
RIO DE JANEIRO

LEGEN
5 AIR HOURS AT 200 M
FLIGHT PA
ALLIED TERR.
A

THIS MAP AS OF SEPTEMBER 1, 1943

L D

E N D

AT 200 M.P.H.

FLIGHT PATHS

AXIS

TEMBER 1, 1943

A true conception of the grand strategy of war in the air is possible only when we consider the earth as one gigantic air base where operations can be carried on wholly eliminating the old concept of sea bases or terrain. We must learn to see an earth where everything topographical has been removed, except for the actual location of cities, centers of industry, and national resources; and, as shown in the gatefold facing, an earth where all transportation routes are straight flight paths between strategic points, eliminating any consideration whether these flight paths lie over land, sea, jungle or polar ice. Once this picture is clear, we see the use of air power to destroy an enemy's capacity to make war as a problem involving only the production and tactical employment of the tool of air warfare.

North American "Mitchells" and Martin "Baltimores" from African bases carry the war to the Axis over the Mediterranean.

WAR IN THE AIR

THE Army Air Forces at war are responsible for four clearly-defined missions. Two are related to objectives of the ground forces; the third involves a new concept of war; and carrying out the fourth makes it possible to complete the other three. Here, without any thought of ranking their importance, are the four missions:

First, the Army Air Forces must protect our factories, railroads, stores, homes—the whole national economic structure—and they must also protect all of our military establishments, at home and abroad, against attack from the air. This is Air Defense.

Second, they must support the ground forces by machine-gunning, bombing and strafing the enemy's communications, troop concentrations, ammunition dumps, motor transport pools and airdromes. They must carry parachute troops and infantry to be landed at advanced points. They must deliver food, supplies, ammunition and even transport facilities for those troops. They must lay an aerial barrage in front of an attack, and delay the enemy when it is necessary for our soldiers to retire. They must photograph everything the enemy does and has, thus becoming the eyes of the Army. This is Air Support.

Third, they must operate an independent force of long-range bombers to strike, without the aid of surface arms, far behind the enemy's lines, directly at his capacity to make war. This is Air Power.

Fourth, they must supply the equipment, the spare parts and the personnel required to keep the complex machinery of air defense, air support and air power functioning. This is Air Service.

When military airplanes are used for defense or support, their function is that of "artillery on wings." They fight other aircraft, or they attack enemy installations and forces on the ground; but they are essentially a weapon—comparatively new and appallingly lethal, but still just a weapon—with which armed force opposes armed force in a two-dimensional war.

When military airplanes are used to destroy enemy resources beyond the reach of ground power—food reserves, materiel,

Skimming over the ground at less than 75 feet, this AAF Douglas "Havoc" rakes Jap planes at Lae, New Guinea.

transportation centers, industry—then the airplane is being used as an independent arm and it becomes air power in its own right. It gives us a new, third-dimensional concept of war, and we have what is meant by "War in the Air."

This distinction between military, or auxiliary aviation, and air power as an independent means of waging a new kind of war, is important to an overall understanding of the main problems which face the Air Forces, and to an understanding of the reasons why they must be used both as a separate striking force and in co-ordination with the ground forces.

Coldly practical considerations dictated the development of this strategy by General Arnold and his air commanders. They were unalterably convinced that air power eventually could stop the production and flow of key war materials—machines, weapons, ammunition and fuel—which are the lifeblood of the Axis war effort. They also knew that to do this they must set and maintain a schedule of smashing all of the enemy's crucial sources of production. Destroying a few sources, or parts of many sources, would be useless.

The strategy of air power is to select certain basic things which are vital to the enemy's entire economic structure, then by continuous, accurate pounding, with sufficient weight, completely destroy both his supply of those things and his capacity to produce them. Here, over-simplified but basically sound enough, is an example of how this doctrine could be applied: While propellers may be assembled in a number of widely scattered places, they are highly complicated mechanisms which, for practical purposes, cannot be manufactured in more than a comparatively few plants at any one time. In attempting to break down enemy air power, the objective might be to single out and totally destroy all propeller factories. This strategy is based on the doctrine that no one thing will win a war but the lack of some one thing may lose it.

Taking this strategy out of the planning stage and putting it into the air demanded thousands of long-range bombers, and building those bombers presented problems for which even American industry had no precedent. It also demanded the crews to operate those bombers—pilots, navigators, bombardiers, gunners, engineers and highly skilled mechanics. These men had to be trained; first as individuals, then through long arduous months in the technique of working together as combat teams.

While the basic policy of America's Air Forces is to build air power, and through strategic precision bombing to strike directly and overwhelmingly at the Axis' means to resist, it has also been vitally essential to develop a superlative air defense and air support. In the process of getting ready to fight our war in the air, the Air Forces have been compelled to take an exceedingly active part in fighting an all-out war on the ground. Paradoxically, our existing weapons of air power, our Boeing *Flying Fortresses* and Consolidated *Liberators*, have been used more in support of ground and Naval operations than as a part of the independent striking force for which they were designed.

To use air power as a conclusive force against the Axis, we must have the necessary fleet of bombers, plus everything it takes to maintain them in operation, including the bases from which they can operate. Bombers do not yet take off from the factory, fly across the top of the world, climb above effective antiaircraft fire, drop 10 or 12 tons of high explosives squarely into the vulnerable entrance to a submarine nest, fight off two or three hundred enemy interceptors, then return

Heavy bombs are fused, finned and loaded aboard a "Liberator" for a raid against a Jap air base.

home and repeat the chore in the late afternoon. In practice, combat conditions limit the striking radius of even our longest-range bombers to substantially less than we might expect, even in shuttling, non-stop operations.

The facts are that, until the present, 500 miles out and 500 miles back, is close to the practical operating limit for a plane carrying three or four, or more tons of bombs fast enough, and high enough, and with armament and armor enough to stand a reasonable chance of getting back. An airplane which could safely be flown 3,000 miles at its economical cruising speed might be forced down after 1,800 if much of the trip was made at full throttle. It is true that many bombardment missions are flown against targets 750 and more miles away, but when this is done, the load of bombs carried or reserve gasoline for "detours" around enemy fighters, bad weather, or anti-aircraft, have to be sacrificed.

There is every reason to believe this operating radius may be increased during the next year or two—certainly to 1,000 miles and possibly more. But no air strategist builds his plans for today's war in the air on what next year's equipment may do—and today air power must have bases within 500 to 750 miles of the enemy resources it expects to destroy.

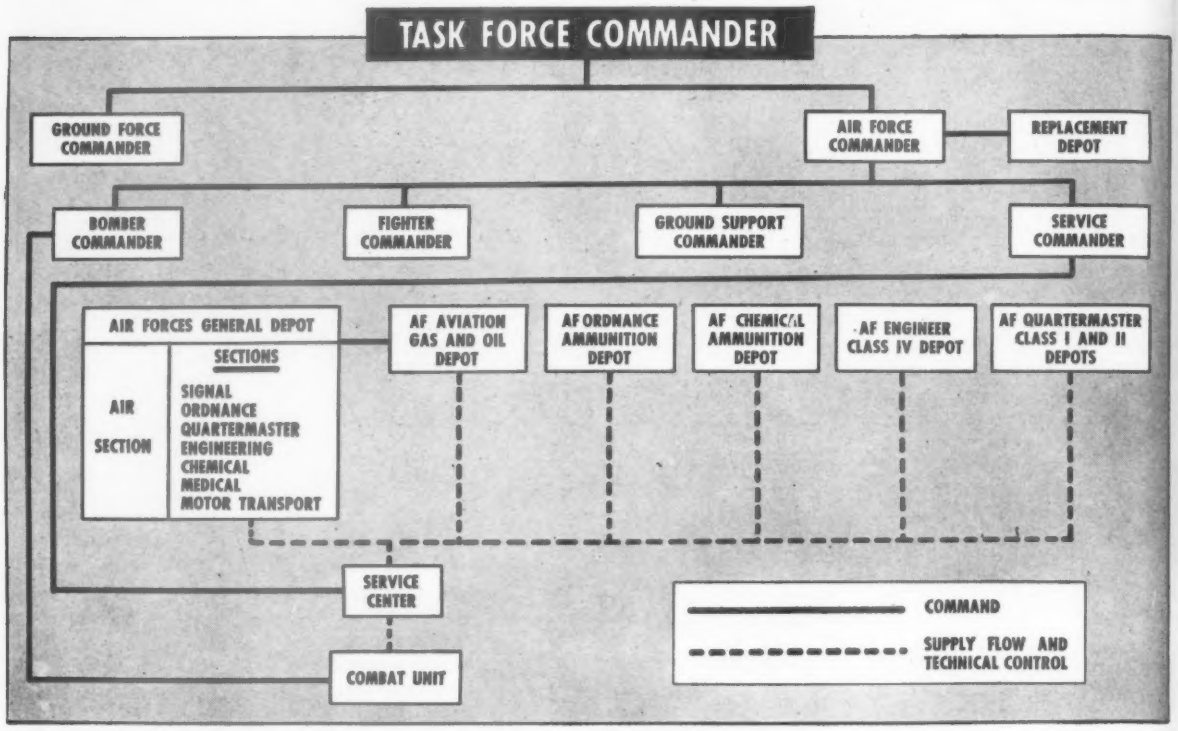
Winning and holding bases for air power is one of the major missions of ground power, and to carry out that mission ground power must have the right kind and amount of support in the air. This completes the circle.

Oddly enough, the factors which have slowed the development rate and the actual tactical use of United States air power as an independent striking force—the limited range of bombers now in service and their dependence on comparatively advanced bases—have worked more for than against us. Had the striking range of air power been 2,000 miles instead of 500, certainly Germany and probably Japan would have built bombers instead of putting their emphasis on lighter attack aircraft designed for use in conjunction with their ground forces. Had they done that, we might easily have been hit with a dozen Pearl Harbors instead of one—but the striking range *was* 500 miles, and Germany and Japan *did* turn to the less expensive and easier and quicker-to-build bombers and fighters.

In World War I, 50 miles out and 50 miles back was a long trip for the most advanced airplane of its day. Yet it carried only a few hundred pounds of bombs. Today, what General Arnold has called the "last of the small bombers" are carrying from 20 to 40 times the bomb load of 1917's "big" planes, and doing it at three to four times the speed for 10 to 15 times the distance. If we look beyond the service bombers in actual combat operation and compare the planes which are now being readied for production with their forerunners of 25 years ago, the progress is phenomenal. It is not too imaginative to say that military aircraft of late 1943 and 1944 will resemble what the Army Air Forces had in December, 1941, to just about the same extent that an early B-17 resembles the old DeHavilland 9.

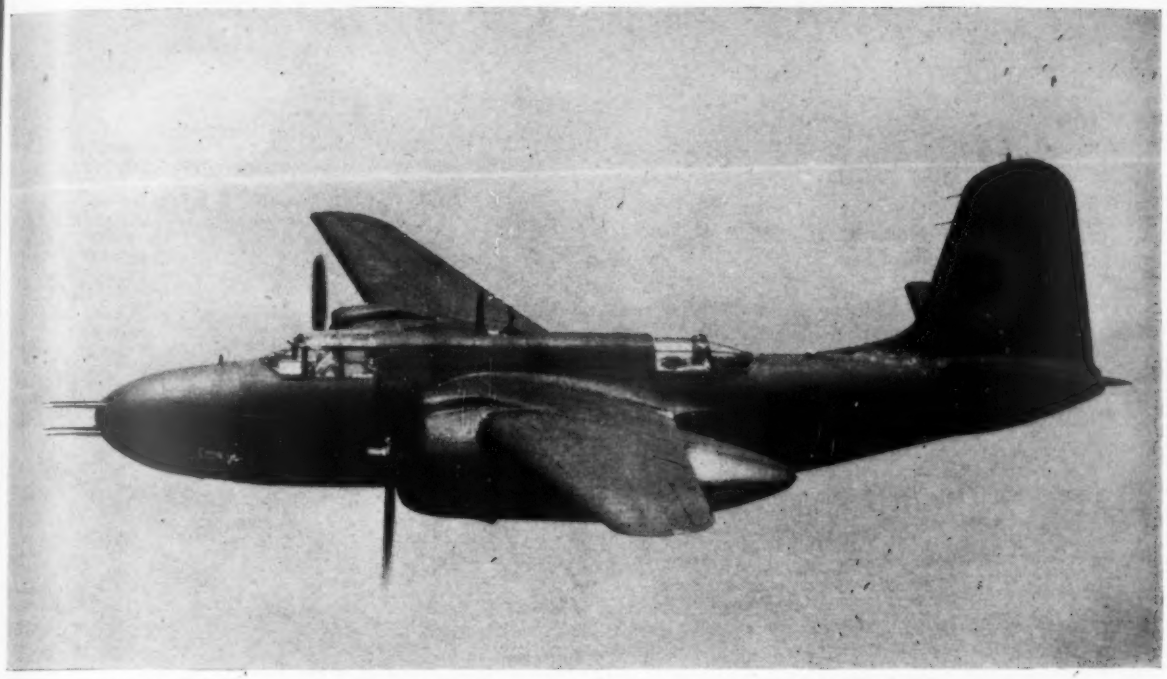
The geographical position of the United States will no longer give this country protection from enemy air power operating from any part of the world now under Axis control. Five or 10 years ago, that statement would have been a prediction; today it is simply a conservative projection into the future of about half the present rate of air power progress, done to give us a realistic picture of what we may expect two to five years hence. Actually, to see that picture it is only necessary to look at the world as men who fly see it today.

TASK FORCE SERVICE COMMAND ORGANIZATION
(Outside U. S. Continental Limits)



From the general depot to the service center, a broad organization of service stands behind every air combat unit.

Carrying paratroopers behind enemy lines is part of the plan for air support furnished the ground forces by the AAF.



Typical of the ever-increasing strength of air power is the Douglas P-70 night fighter with four 20 mm. cannon.

Consider this time table recently published by one of the airplane manufacturers:

From	To	Airline Miles	Hours
New York	Berlin	3,960	20
Chicago	Singapore	9,365	47
New York	Capetown	7,801	39
San Francisco	Wellington	6,759	34
Washington	Moscow	4,883	24
London	Rome	887	4.5
New York	London	3,460	17
London	Berlin	574	3

The Army Air Forces map which accompanies this article is worth a lot of study.

Each of the color bands of orange and white on the flight paths from Washington represents five hours of flying time at only 200 m.p.h.

Today the Atlantic is only 400 minutes wide for transport loads flown at transport speeds. Tomorrow it will be less than 400 minutes wide for bomb loads flown with combat gasoline reserves!

From North Cape, Norway, a German-held air base, it is no farther to Seattle, Wash., or Des Moines, Ia., than it is to Washington, D. C.

Washington is nearer to Berlin than to Rio de Janeiro. There is no such thing as "hemisphere security" based on the geography of the past. Detroit and all of our other great war production centers are nearer Russia than are any of our seaports, excepting Seattle.

Australia and San Francisco are a mere 35 hours apart. Our bombers hop from the U. S., touch Brazil and sit down in Africa ready for combat service, in 27 hours flying time.

This new global concept of time and space must dictate all future strategy, both for war and for the preservation of peace, just as it has dictated the overall strategy which guides the use of our Air Forces today.

Allied air power based in Russia, Africa and England is gradually closing in to the point where it can hammer, selectively, mercilessly and continuously at every critical Axis resources from the rim of a huge wheel of which Germany is the hub.

England is an important base, well within present bombing range limits, for the all-out use of air power against Germany proper. It has important resources, a large army for defense and eventual invasion of the European continent, and the supply line from the United States is comparatively short. England's main weakness as a base for air power is its limited size. Long-range bombers require large fields, well dispersed. The number of bombers which can be based in England is less than will be required for the final blows to German power. This fact, combined with the encirclement it makes possible, was largely responsible for our strategy aimed at developing Africa into a base comparable to Britain.

In North Africa there is ample space for dispersion. Because of its position between the Mediterranean and the desert it is relatively free from any threat of attack by ground forces. The supply route from the United States is only about one-sixth longer than from the U. S. to Britain.

The second phase of our overall strategy concerns Japan. The main problem will be the same as that presented by Germany: To so base our air power that we can strike directly at the heart of the octopus and thus paralyze its enveloping tentacles. How this strategy will be worked out—exactly where our bases will be established, and just when they will be established—are questions which must be answered by the higher command of the Army Air Forces. That they will be answered is assured by the magnificently executed approach to the tremendous task the command has already carried to a point where Germany's defeat is a matter of time and no longer one of conjecture.

World War II has taught us four principal object lessons:

1. *Air power is not a panacea.* It is not a force which by itself can defeat an army or capture an enemy's territory. It is no more independent of land power than land power can be of air power. Both forces must be used, and used to the full extent possible, before victory can be achieved and a lasting peace assured.

2. *Air power must not be developed at the expense of land power,* nor must air support of land power be neglected. Each supplements the other.

3. *Air power has added a third dimension to statesmanship as well as to war.* No concept of military or economic security is safe which ignores the changed global relationships brought about by air power.

4. *We will never again be given the opportunity—still ours today—to build air power after it is needed.* We can make it this time; we'll win our war, and we'll win it in the air—but we must not risk another. END

Bomber crew back from Mediterranean mission is carefully questioned for data that might lead to improved planes and equipment.

Lessons from Combat

In the mercurial business of war, the ideas for changes in equipment and tactics born on the front are speedily weighed and perfected for combat.

WHEN the war is over and it is possible to evaluate the methods by which our Army Air Forces have kept on top of the enemy there will be no more fascinating chapter than that which will tell of how reports from the front were handled and implemented. Improvements in various types of planes and equipment are common knowledge to the enemy as well as to ourselves. Just how those improvements were brought about, just how they will continue to be brought about, are things the enemy does not yet know. He has been surprised in the past—and he will be in the future.

Those surprises are not guess work. They are due to one of the major divisions of the Air Staff, with an assistant chief of air staff at its head and representing it in all major councils. It is called the Division of Operations, Commitments and Requirements and its functions are as comprehensive as its title.

It might be compared to a handsomely functioning sales engineering section in the organization of a commercial manufacturer with a world-wide market. In effect it is just that in a war organization. Its customers are the boys who are fighting in the air in every corner of the globe. Its duty is to find out what those "customers" want and to see that they get it.

Those customers, our fighting pilots, are in themselves as varied as any cross-section of young Americans. Their tasks are infinitely more varied than that of any comparable civilian cross-section because they are carrying out those tasks from the Arctic to the tropics and in almost every degree of longitude around the globe.

Their tasks, their lives, indeed, depend upon the assemblage of the most complicated sets of mechanisms that has ever developed, from the emergency ration they carry on their coverall pockets to the 30-ton bombers in which they may fly. It includes everything from the kinds of rivets in those bombers to the bombs they drop and the projectiles they fire from their guns, from the sextants by which they determine their positions to the motors that get them there.

Out of that maze of complication it is natural that the reaction of the customer varies to a degree that would drive frantic the manufacturer of an automobile or a soap powder which he hopes will please the largest possible number of Americans living peacefully in the relatively standardized condition of normal American life. It has not driven frantic the Division of Operations, Commitments and Requirements.

The basis of its effectiveness is an assemblage of statistical experience which would gladden the heart of a life insurance actuary. A gunnery sergeant from the Southwest Pacific may tell his squadron commander on landing that he got that so-and-so Zero because he did this and that with his .50 caliber

Ideas for better bombing tactics—such as skip-bombing—arise from such actions as this sinking of Jap ship at Guadalcanal.

machine guns. "All machine guns should be rigged that way," the sergeant may exclaim. His exclamation is not regarded as latrine gossip. In due course it reaches Washington—and it doesn't take long. Most of these reports come by radio.

But, once in Washington, that report will be lined up against hundreds, perhaps thousands of other reports. Mathematics may show that the Southwest Pacific gunnery sergeant was just lucky—that other gunnery sergeants in his own or other theaters found that if they did his particular "this or that" with machine guns they got killed. On the other hand his report may coincide with the proven experience in other cases. Immediately there go from Operations, Commitments and Requirements orders that will carry out the sergeant's wishes.

A whole vast industry may be transformed to do so. Some industries have been transformed in accordance with such reports. Some civilian manufacturers have complained that the Government can't make up its mind. They are wrong. The Government is making up a mind that must be kept fluid to carry on the mercurial and ever-changing business of war. And it changes its mind for no reason but facts, facts which have been accurately assembled, carefully weighed, and judged by experts.

When there is confusion in facts the division never hesitates to hurry its own experts into the field and assess the facts at first hand. That is seldom necessary, for there is a constant flow of officers and other experts from the front, home for rest and recuperation, for the instruction of others and, often most importantly, to contribute their personal and practical knowledge to the assessment of facts in the Division of Operations, Commitments and Requirements.

No better example of how these reports are handled can now be cited than the development of the *Flying Fortress*. They had a rough time of it in the beginning, right after Pearl Harbor, when the Japs found they could come in on their tail with impunity. It is song and story now how some of those

(*Continued on page* 354)

AAF bombs burst upon airfield at Lae, New Guinea. Ideas for new-type equipment or bombs may come from similar missions.

MISSION

Crew of "Flying Fortress" ride truck into headquarters at an 8th Air Force base after a successful mission over Europe.

A behind-the-scenes view of a bombing mission, with the crew members telling their own story.

A LARGE part of the world, from the continent of Europe to the farthest Pacific isles, will for long bear testimony to what the term "mission" means to American airmen. In its narrowest sense "mission" means that these boys have carried out orders given them in a briefing room. In its wider sense it means that they are accomplishing the task in war for which they have been trained for many long months and for which their equipment and tactics were developed over many long years.

For the entire development of the big American bomber, its medium-sized sister and the fighter planes that protect their bases and escort them in the air, has been aimed at the accomplishment of these precise missions. And they are precise missions. The men and the equipment are too valuable to risk on objects of frivolous selection or on any mere effort to terrorize or injure civilian population. Every mission must be an integrated part of the whole strategy of the war.

In the Pacific, so far, most missions have been aimed at Japanese shipping and the centers in which it gathers to distribute arms and supplies to the widely scattered Japanese ground and air forces. In Europe the mission is also aimed at centers of production. But in each instance it may be confidently assumed that the target has been chosen for a special reason, widely scattered and variously assorted as those targets may appear to the layman.

For instance the battle of Tunisia was being fought 15 months before the first shot was fired on Tunisian soil. When the RAF blasted the Renault works near Paris it cost the Afrika Korps enough tanks and trucks to equip two and a half armored divisions. When the Matford works at Poissy were bombed in April, 1942, the Germans lost an estimated 4,660 trucks that might have been very useful in hauling up supplies to Rommel. The destruction of the Schiess Defries machine tool works at Dusseldorf last year delayed the whole German war production for many months. So, just as the battle of Tunisia was being fought in the months that saw RAF and American raids on Rostock, Essen, Cologne, Osnabrueck, St. Nazaire, Brèmen, Duisberg, Rouen, Lille and Hamburg, so the battle of Europe is being fought today as the big fleets roar over their selected targets—and hit them.

These missions, in short, are the precise long-range counterpart in actual combat to the hand grenade that knocks out a machine gun and enables infantrymen to take the post it holds. The long-range bomber just as surely removes a weapon from the hands of an enemy.

How conscious our men are of the importance of these missions is revealed in transcripts of their conversation while on the job. Bombardiers say they sometimes feel terribly alone out there in the Plexiglas nose of a *Fortress* or *Liberator*. But they add that when the bombing run comes they are so concentrated on their task that they know nothing else. There is even the story of Lieut. Jack Mathis who was struck full in the body by an antiaircraft shell. The doctor said afterwards that he should have died instantly. Yet the navigator saw him, after he had been knocked from his chair, crawl back over his bombsight, aim and release his bombs and throw the switch that closed the bomb bay doors before he fell.

The navigator's job is to bring the plane to its target. But the bombardier takes over when the target is reached. Here is how he generally sounds. This is a record of the conversation of Lieut. Robert G. Abb, of Stevens Point, Wis., during a recent raid over Germany.

"Target below . . . 'bout 15° left . . . maybe six miles . . . watch that formation, George . . . stay in there tight and when

The result of a "Flying Fortress" raid on seaplane workshops and U-boat pens at St. Nazaire, France. Nearly four acres of dockside were devastated. Thin streams of smoke (upper right) were a Nazi attempt to screen base.

I call for a level, that's what I mean . . . quick . . . watch toward the sun for fighters . . . lead group is going in now. . . . Top turret! fighter at 11 o'clock our level . . . they look like Focke-Wulfs at four o'clock. . . . Get that so-and-so, Remmell . . . flak closer . . . start evasive action, George . . . here he comes, top turret . . . c'mon, Remmell, hit him! . . . nice shooting . . . think you got him. . . .

"Give me a level, George . . . start the camera, Beezy . . . hold that level . . . watch the air speed . . . bomb bay doors open . . . steady, steady, just a little longer now . . . level, dammit, level . . . hold 'er level . . . level! . . . Steady! . . . *bombs away!* . . . let's get the hell outa here!

"Flak on the other side now . . . there goes a *Fort* out of formation ahead . . . watch him, ball turret. . . . Get that guy at 11 o'clock, Ernie . . . come on, you're shootin' too low . . . you're under him . . . bring it up! . . . bring it up! . . . bomb bay doors closed . . . camera off, Beezy. . . . Boy, the eggs were right in there, gang . . . swell bombing . . . look at that smoke down there . . . wotta mess! . . . Any sight of that *Fort* that went down?"

And the pilot takes over for the flight home.

Lieut. Olan L. Hubbard of Dallas, Tex., a group bombardier, made these notes on his way home from a raid on the Renault works at Paris.

"As we go out, we have just crossed the French coast. It is only a few minutes now until we reach the target outside Paris. I can see the river Seine over to our right as it makes its turns and curves. From here it looks like a silver snake in the sun's reflection. I hope I can follow it all the way because our target lies just in the middle of the second big bend it makes after it enters the suburbs of the city.

(*Continued on page* 224)

A Jap aircraft carrier desperately tries to evade bombs during Midway battle. Sharp swerve avoided bombs at top.

"AAFSAT"

Every conceivable phase of actual warfare is simulated in the Army Air Forces' School of Applied Tactics. Fighter pilots (above) race to their planes—"Warhawks," left; "Thunderbolt," right—to intercept reported enemy "raid."

A dramatic dress rehearsal for war is staged continuously in the AAF's unique new 8,000-square-mile Florida "war theater."

THE air battles of 1944 are being fought and won today at the Army Air Forces School of Applied Tactics.

That is the mission of AAFSAT. The men who are schooled there today are the officers and "non-coms" who will fill key slots in every Air Force group that hits the enemy this autumn and next year—and the years to follow, if necessary.

The School of Applied Tactics is more than just a school. It is a complete air force, with an up-to-minute fighter command, a technique-wise, battle-tested bomber command, an eager versatile air support command, a veteran-staffed, smoothly-organized air service command.

AAFSAT is more than the headquarters and 1,200 acres of camouflaged classrooms, barracks and synthetic devices. It is a system of 12 airdromes ranging from a vacant field (quickly scraped out of the sand, palmetto and cutover pine—as rugged as any on any battle front) to fabulously large bomber bases with 10,000-foot runways.

AAFSAT is more than a system of fields specialized for fighter, bomber and air support work. It is an 8,000-square-mile "war theater" on the Florida peninsula, where "enemy" bases and maneuvering convoys and fleets are bombed daily, where "enemy" raiding formations are repelled by day and by night.

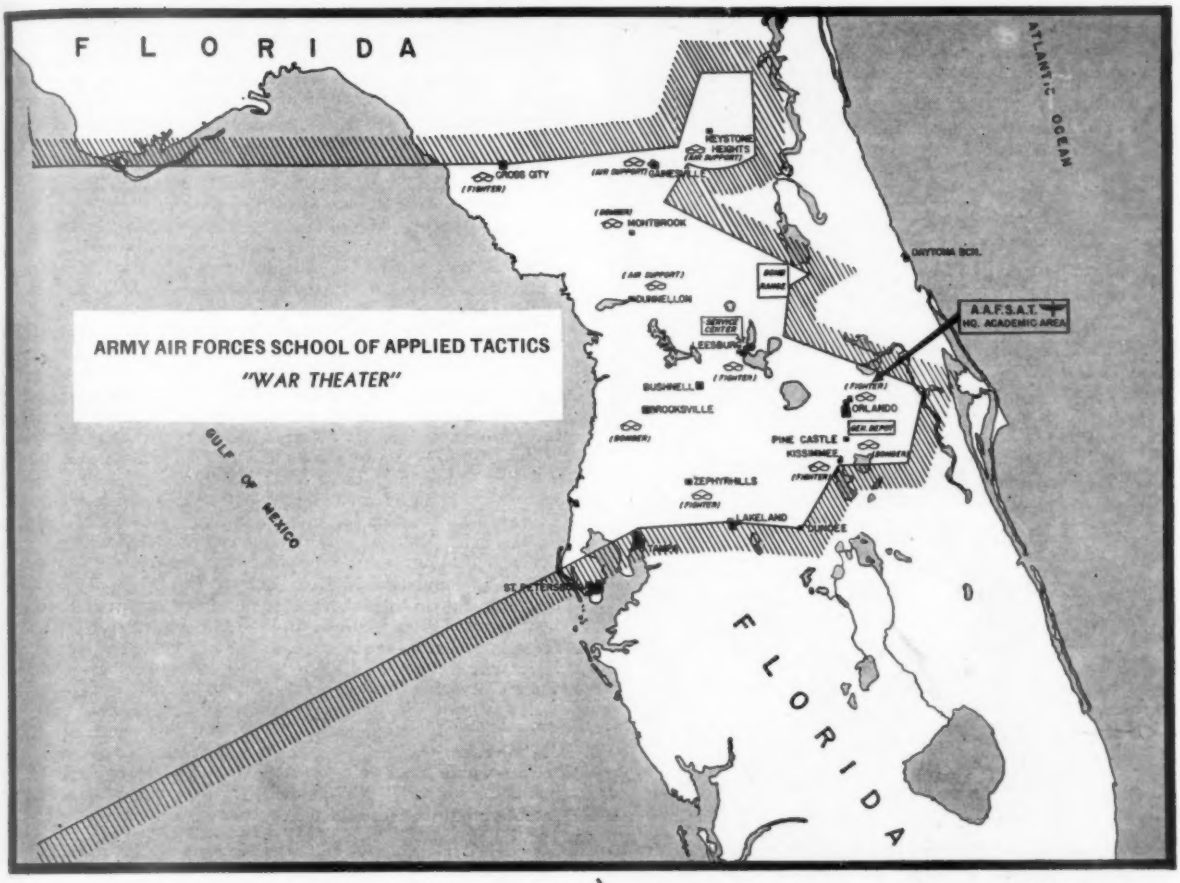
AAFSAT is more than a staff of skilled Air Forces training instructors and administrators. Many of its lecturers are officers freshly returned from scattered air theaters. All of its courses are corrected, reviewed and appraised by men who have "been there."

AAFSAT is more than instruction to individuals in the best technique for bombing a target, shooting down a bomber, baking a loaf of field bread or repairing an engine. AAFSAT students get on-the-job training in the teamwork of successful air warfare. More far-reaching than the crew synchronization within the skin of a bomber is the brand of know-how and teamwork which will thread throughout AAFSAT-trained squadrons, groups and commands.

AAFSAT is more than a place where the newest combat units are schooled in the most modern techniques gleaned from information obtained in active theaters. It is itself a laboratory theater where new ways are developed and tested, where the newest equipment is tested for tactical employment, where new methods are worked out to make equipment at hand more efficient.

The mission of AAFSAT is: (1) To train Air Force cadres—the personnel framework around which all new combat groups are formed. (2) Test and develop new techniques. (3) Speed new developments and methods out to the theaters of combat.

The students who come to AAFSAT are picked men from organizations in one of the training air forces in the United States (Second Air Force or Third Air Force). For instance, the commander of the II Bomber Command must whip up a new heavy bomb outfit which must be ready for shipment to a theater by a certain time. Out of organizations already in his command he picks out a cadre of some 150 officers and



ARMY AIR FORCES SCHOOL OF APPLIED TACTICS
"WAR THEATER"

Unique in military training history, the huge AAFSAT "war theater" outlined above involves widely-separated fighter, bomber and air support commands. Under simulated war conditions, "enemy" bases, convoys and fleets are bombed daily.

enlisted men for the group headquarters staff and four squadrons. These people may then go to AAFSAT.

There will be the group commander, his executive, the adjutant, intelligence officer, photo interpreter, operations officer, weather, communications, medical, materiel officers, some bombardiers and navigators. There will be the squadron officers for similar positions. Enlisted chiefs for the inspection of armament, airplanes, chiefs for communications, operations, intelligence, supply, radio operator-gunners, engineer-gunners and armorer-gunners also are included in the cadre selection.

This bomber group cadre then goes to AAFSAT for a month's assignment. In the first few days the whole cadre, from corporals to colonels, sit in on a series of lectures to brush them up on some of the latest broad developments of air force organization, subjects of a general nature vital to everybody in a smooth-clicking outfit.

Then the administrative and service personnel, such as the adjutants, supply sergeants, line chiefs and the like, attend classes conducted by the AAFSAT Air Service Department. The operational personnel, such as the group and squadron commanders, bombardiers and navigators are lectured on new tactics and techniques of bombing as learned in the various theaters and as developed at AAFSAT. They'll use the maximum training devices and synthetic gadgets constructed for their specialized purposes.

From classroom life the cadre moves out to one of the AAFSAT fields. They'll live in tents under conditions which will approximate life at a newly-won airfield, up toward a combat front.

At these outlying fields the cadre will work with members of the demonstration squadrons and groups, most of which are headed by officers and men already veterans of several active theaters.

One of the many pilot rooms in the AAFSAT theater provides a meeting place for plane recognition and tactical studies.

AAF mechanics learn to work with a minimum of equipment.

In case of "enemy raid," mobile unit makes quick getaway.

Repairing a plane wing at mobile shop in Florida "jungle."

At the end of a month the cadre returns to the parent Air Forces. It becomes the skeleton framework of experienced personnel around which a new group is trained and assembled. The men are the leaders and teachers during the Operational Training Unit stage of their preparation for combat assignment.

The advantages of such a program are:

1. It will introduce airmen to new equipment which may not be in sufficient production at the time to outfit everyone, but which will be abundant by the time they are completing their OTU phase. These airmen can learn the full capabilities and limitations of such new equipment. There have been some disastrous instances in which certain radio devices, as an example, weren't used to full advantage because the planes were more modern than the training of the crews.

2. This training will help prepare a new group being sent to a theater. The latest information on what the enemy can and will do is told them at AAFSAT. A great many losses are due to accidents and failures and other causes besides enemy action. Many of these losses can be prevented by a little forewarning as to what each man can expect out of his fellow soldier, from other squadrons and commands.

3. A tremendous morale boost results from AAFSAT training. This is based on the simple fact that if the whole Air Force unit knows its job and what the commander is driving at, there will be less questioning and fewer timid spirits in the organization.

With a complete model air force to work in, AAFSAT students have the most elaborate layout of equipment and facilities in the world for their laboratory. Although the AAFSAT air force is scaled down in the number of planes and squadrons, it is the best-rounded and, theoretically, the best air force the nation has.

Headed up by recognized, battle-wise fighter pilots, the Air Defense Department is a fighter command with squadrons at four bases scattered over the AAFSAT theater of operations.

The whole AAFSAT theater is curtained against enemy bomber raids (real or simulated) by a system of super-secret radiolocation devices which keep tab on every plane over that part of Florida.

With highly-developed radio control, student fighter pilots are trained in the procedures and tactics for controlled interception of enemy raids. Controllers sit at information centers and literally play a game of aerial chess with mock bomber raids seeking to penetrate objectives in the AAFSAT theater.

The secrets of night fighting, one of the most amazing chapters to be written of this war, are unveiled to fighter cadre students. Also protecting AAFSAT objectives are bands of searchlights, manned by antiaircraft artillerymen, Signal Corps personnel, RAF gunnery experts and WAAC. In all divisions are combat veterans and observers from the war zones.

The demonstration fighter squadrons are commanded by former AVG pilots and aces from Southwest Pacific fights with the Japs.

The Air Defense Department is a carry-over from the fighter command school established in the spring of 1942. In addition to the training of the fighter cadre personnel sent to AAFSAT by various air groups, this Department continues to train individuals as controllers, day and night fighter pilots, specialized radio men, antiaircraft staff officers and maintenance men.

In addition to the fighter aircraft, bases, and squadron setups at AAFSAT for the students, there are very elaborate synthetic devices where much of the procedure for successful interceptions is drilled into students before they tackle actual operation problems.

The Bombardment Department (which functions as a bomber command in the AAFSAT demonstration air force) hammers home to its students the gospel of precision bombing.

Student commander and their top-flight combat crews get a thorough schooling in the U. S. policy of attempting to hit an exact target with a specialized bomb where the most strategic harm will result to enemy production, overhaul depots, service facilities or submarine pens. It is demonstrated to them that more damage can result from four accurate hits with 2,000-pounders than with one 8,000-pound bomb. They'll be schooled in the best methods for attacking the highly precision target of a maneuvering vessel.

Tactics and technique of this "dead-eye" science occupy a

(*Continued on page 256*)

STRATEGIC BOMBING

Smoke rising from harbor installations show that "Fortresses" over the Lorient submarine base have found their mark.

By transforming air power into a primary weapon, the long-range bomber permits us to blockade the enemy internally.

MOST of us have been astonished and puzzled by the controversy which has raged over air power. What is its scope, its importance, and its true function? What are its weaknesses?

What *is* air power?

Reasoning and logic will have to help us answer. Examples must depend upon logic for their proof. Why? Because air power, whatever its composition and scope, is still an infant. Its real effectiveness lies in the future.

Air power today is little more advanced than was sea power when Phoenician traders were arming their galleys for naval warfare. We are nearing an air concept analogous to the British proof that real sea power united armed fleets and commercial shipping. Sea force was necessary to clear the way for the shipping which was vital to her existence. In any event, Britain proved the soundness of this thesis for an island nation in a world consisting mostly of water.

Today every nation is an island in a sea of air.

The real subject of this discussion, however, is not air power but air force. The two terms are not the same.

Air power involves the entire air problem of civilian air activities as well as the military aspects. It includes factories, airlines and private flyers.

Air force is only that part of the national air power which is devoted to military operations—strategic, logistic and tactical. This, of course, is of paramount interest in war.

Air force, like sea force, is not simple, and it is all the more difficult because of its comparatively recent birth. Earlier peoples must have had similar difficulties in trying to define sea force. They must have been rather hazy in allocating functions to ships of various kinds and sizes.

Early naval men often made the same mistake as a few air power advocates, claiming that the new weapon eliminated the older arms. But the natural forces of evolution maintained a balance within the sea forces as well as between the sea and land.

Air power does not completely revolutionize or outmode older concepts of warfare. It lengthens our reach, increases our striking distance and speeds our blows, but it does not change the basic principles of warfare.

In surface warfare we always attempt to crush resistance by hitting enemy forces directly and by attacking the flow of forces and supplies to the battlefields. Killing armed men is one means of attaining victory. Strangling his supply channels is another.

Air force merely increases the scope. It enables us to assist our front line forces by hitting the enemy in the immediate forefront and just behind his lines, attacking his supply dumps, his roads and his strong points in much the same manner as ground artillery. But it is not as limited in range as is artillery. The airplane can strike deep inside the enemy territory beyond the range of the most powerful ground gun.

STRATEGIC ATTACK

Bombing theory described in this article is put into practice before the invasion of Sicily. In the first photograph of this remarkable sequence, bombs are hurtling toward Milo airfield.

When the enemy occupies territory which is self-sustaining, the destructive power of air force is dominant. Air power now permits the siege of a relatively self-sufficient nation—an internal siege that prevents the supply flow from inside sources to the fighting fronts. This internal blockade equals the possibilities of an encircling blockade which eventually so weakens an enemy that his circumference of defense can not withstand frontal assault. Disintegration of defense, such as occurred in Tunisia, results.

This is the real force in "air force."

It singles out the long-range bomber as the weapon which enables air power to serve as a primary instead of an auxiliary arm. The enemy must still be held and hit on his front lines by every means at our disposal but the internal blockade made possible by the long-range bomber can be used independently to hasten the weakening of enemy resistance and to reduce the ultimate cost of the final assault.

This theory has long been vaguely understood, and sometimes followed, in the use of air force. Yet ground support capabilities often have monopolized air operations.

One can not exaggerate the importance of the ground support effect of air force. This has often been demonstrated. The North African campaigns—from the east as well as from the west—which finally merged into the combined battle for Tunisia were classic examples of the use of fighters and bombers in direct support of ground forces.

Rommel's long line of communications and his ports became a shambles through which supplies passed only at great cost. In Tunisia our fighters and light bombers raised havoc with tanks, trucks and marching troops. Supply dumps and troop concentrations never had moment of safety.

Air superiority in the battle area was spectacular and complete, but it was not an end in itself. Air superiority gave our fighter-bombers and other planes almost free reign over the battle area. This is not always enough, however. The previous spring and summer, for example, the RAF maintained superiority over the German Air Force in Libya and Egypt but failed to prevent the German advance almost to the edge of Alexandria.

Something was missing.

The missing piece was strategic bombing, the air action which

One hundred twenty-two Axis aircraft, including 60 single-engined planes, 29 medium bombers and 33 transports can be seen on the field. Here bombs are blasting one corner of field.

prevented the delivery of enemy essentials to the African area.

Back in March, 1942, there occurred an air action which, beyond doubt, greatly contributed to the distintegration of German defenses. In that month the RAF attacked the French Renault plant, robbing the German army of the equivalent of the heavy transport needed for more than two and one-half divisions. To do the same on the battlefields would have cost untold hundreds in casualties. The RAF lost only a few planes.

Bombing of steel mills, refineries and other industrial units in Europe by the American Eighth Air Force and the RAF further weakened the flow in support of the German force in Africa as well as elsewhere, while other British and American attacks rendered Axis Mediterranean ports almost useless.

Allied fighter interceptions of huge Axis air transport fleets contributed directly to the blockade. Meanwhile Axis needs for air protection against Allied raids over the continent cost many fighters and prevented adequate reenforcement of the dying Axis air power in Africa.

All in all, the Tunisian action was a beautiful example of coordination of all forces to attain final victory. Each served in its proper place. Yet the great historic fact is that this success proved the effects of independent strategic bombing.

Frontal assaults upon such a powerful enemy could succeed only in causing him to withtdraw, except where a breakthrough might permit encirclement of certain forces. This has happened to both sides in Russia. Instead, the German defense disintegrated spectacularly, as from interior decay. Individual units, still intact, wandered around looking for Allied forces to whom to surrender. They could no longer fight as a complete army.

Many who argue against the value of air power cite the Battle of Britain as proof of the futility of strategic bombing. One might as well discredit land and naval power because British forces failed to quell the American Revolution.

The German failure in the Battle of Britain resulted from earlier misconceptions of the possibilities and limitations of air power.

German blitz technique in Poland, Norway, Holland and France allowed no place for the slower process of internal decay which results from real strategic bombing. The classic one-two-three cadence was in Germany's crushing blows directly against the enemy defenses. She designed her airplanes with that in mind and her initial success speaks for itself.

But the German concept of air force was too limited. It contemplated the use of airplanes for only three basic purposes:

1. To attack enemy surface forces at and near the line of contact.

2. To transport men and equipment, sometimes well behind enemy lines.

3. To defend German forces and territory from similar air operations of the enemy.

This worked beautifully until Germany tried to use this weapon—designed and trained for tactical use—in an all-out strategic attack upon a major nation. She visualized strategic bombing of Britain as being the same as the helter-skelter bombing and strafing of front line forces. She thought that she would smother England under a rain of bombs so solidly that the traditional English will would be broken along with British industrial might. The idea was there but the method was wrong.

Nothing that we know about warfare, Mr. Churchill said of air power in 1917, can lead us to believe that bombing for terror alone can cause such a morale collapse as to force a major nation to sue for peace. He said that air power must single out and attack transportation, factories and other enemy installations upon which the enemy war-making ability depends.

England of 1943 is living proof that bombing for terror is futile.

The Allies are now demonstrating the effect of bombing with purpose. But Germany did not visualize the singling out of industrial units as being a refined process. If they had been using super long-range cannon to deliver the projectiles, German tacticians would have aimed their guns at specific factories, docks and other vitals. Why did they suppose their bomber-artillery could cover England with a solid blanket of unaimed fire and explosive so dense as to insure hitting industrial vitals by blind luck and brute force?

Even in the relatively small area of Britain, industry is not concentrated when we measure distance in terms of bombs relatively unaimed, required for solid coverage.

This is said without any desire to detract from the magnificent defense put up by the out-numbered RAF. But this

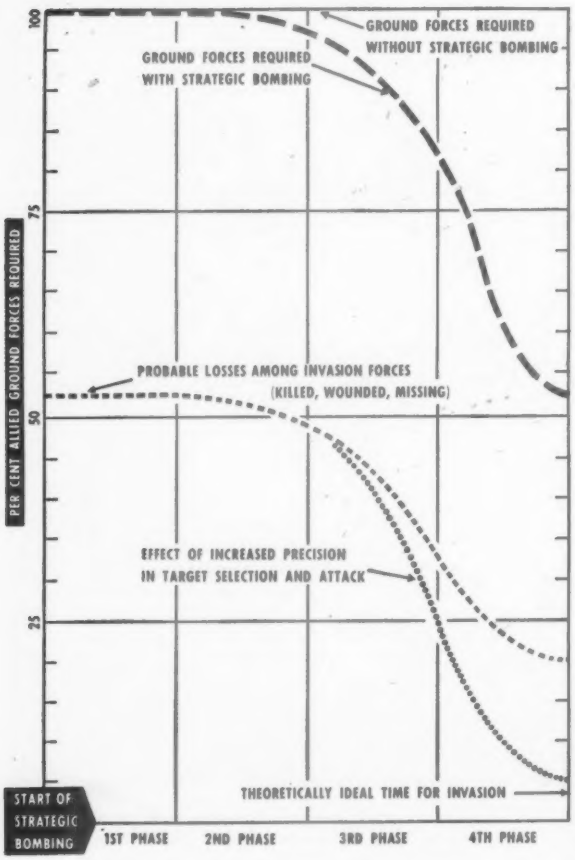
Fragmentation bombs now cover more than half of the field and several fires have been started. An important phase of Allied strategic plans was to knock out enemy landing fields.

The field now is almost completely blanketed with bomb bursts, rendering it useless and destroying or severely damaging nearly all of the enemy aircraft present when attack began.

The Army has proved the effectiveness of high level precision bombing against moving targets such as ships. Here Jap landing barges escape from their blasted transport off Guadalcanal.

★ ★ ★

Strategic bombing should continue until the curves below level off. At that point bombing will have so hurt the enemy that the invasion can start with minimum forces and casualties.



much is clear: When strategy and efficiency called for precision, Germany bombed for terror with unaimed bombs and hoped in vain that chance would aid in hitting vital points.

The American Air Forces have long championed strategic bombing as a basis for their planning of equipment and technique. Efficiency expressed in the military maxim "economy of effort" is an epitome of the air concept upon which we have based all of our efforts and this is best attained in strategic bombing by scientific target selection and precise placement of bombs where they will do the most real damage.

We must analyze enemy industry to determine the relative importance of each type of production. Then we must study the relative importance and vulnerability of each unit of the selected industries. Cities, as such, are not considered, though many units of industry within a particular city may be singled out for destruction.

Such analysis surprisingly shows that a relatively small percentage of hundreds of industrial units need be destroyed to ruin the enemy's ability to wage modern war.

Even then we cannot be prodigal with our forces. If we were using cannon we certainly would aim carefully, yet a bomb is essentially the same as a shell fired horizontally at the speed of the airplane. Whatever our potential wealth may be we still must measure it in finite terms. Our weapons will always be counted in finite figures.

The enemy war machine—and it is a machine—is like an automobile which we want to prevent from running. It is parked at the curb and entirely within our reach. Would we take an axe and start chopping and pounding until we beat it to a pulp? Or would we merely take out and keep the rotating contact in the ignition distributor?

An ancient fable said, "for want of a nail, the battle was lost." We take away the nail.

Though we can stop a tank by killing its occupants, meanwhile suffering casualties of our own, would it not be more economical to destroy the potential tank by taking away the lathe used in its construction? Strategic bombing is aimed at the lathe.

Air power, like sea power, must always be composed of separate types for various functions. Each is necessary to fulfill its purpose.

Fighters are necessary for defense and for attaining air superiority.

Medium and light bombers as well as fighters are vital factors in direct support of surface forces, while longer-range medium bombers also serve in the strategic effort farther to the rear.

Air force, however, reaches its peak expression in heavy, long-range bombers which are the only weapons capable of hitting the real sources of mechanized military power.

Properly employed, a well integrated air force serves to decrease the time as well as the cost of final victory in life and wealth. To determine the proper sequence of operations let us diagram our ground force requirements and potential losses involved in the invasion and final subjugation of the enemy.

The height of the vertical scale in the accompanying diagram represents the total strength of the ground forces required for invasion before any strategic bombing is done. Requirements and losses are plotted against this scale. The horizontal scale will be divided into four time-phases whose lengths are inversely proportional to the strength of our heavy bomber force.

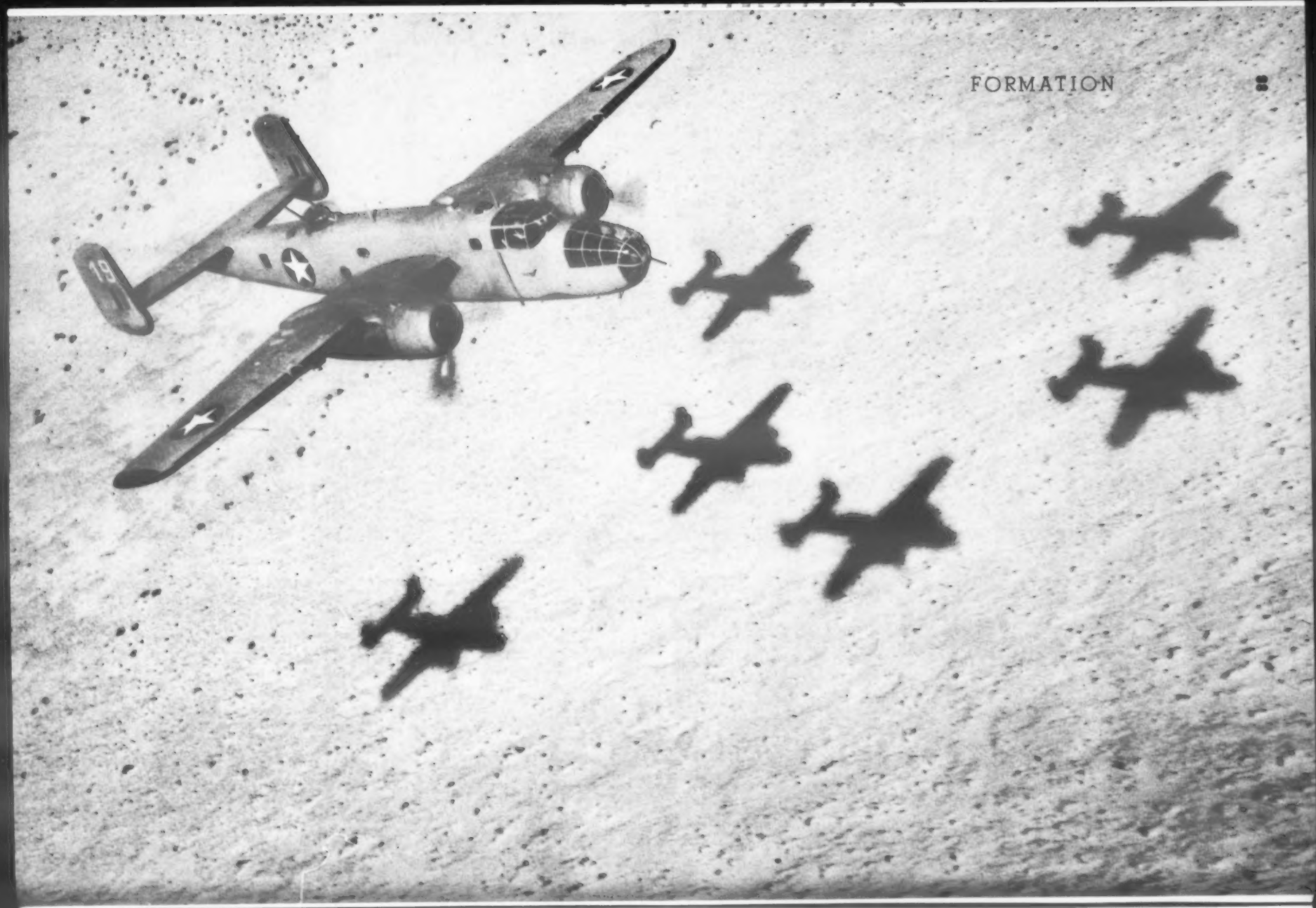
With no strategic bombing, it is readily apparent that the initial point on the ground-force requirements curve is very high, while World War I statistics show that casualties will also be very high. Killed, wounded and missing should be near the 50 per cent mark.

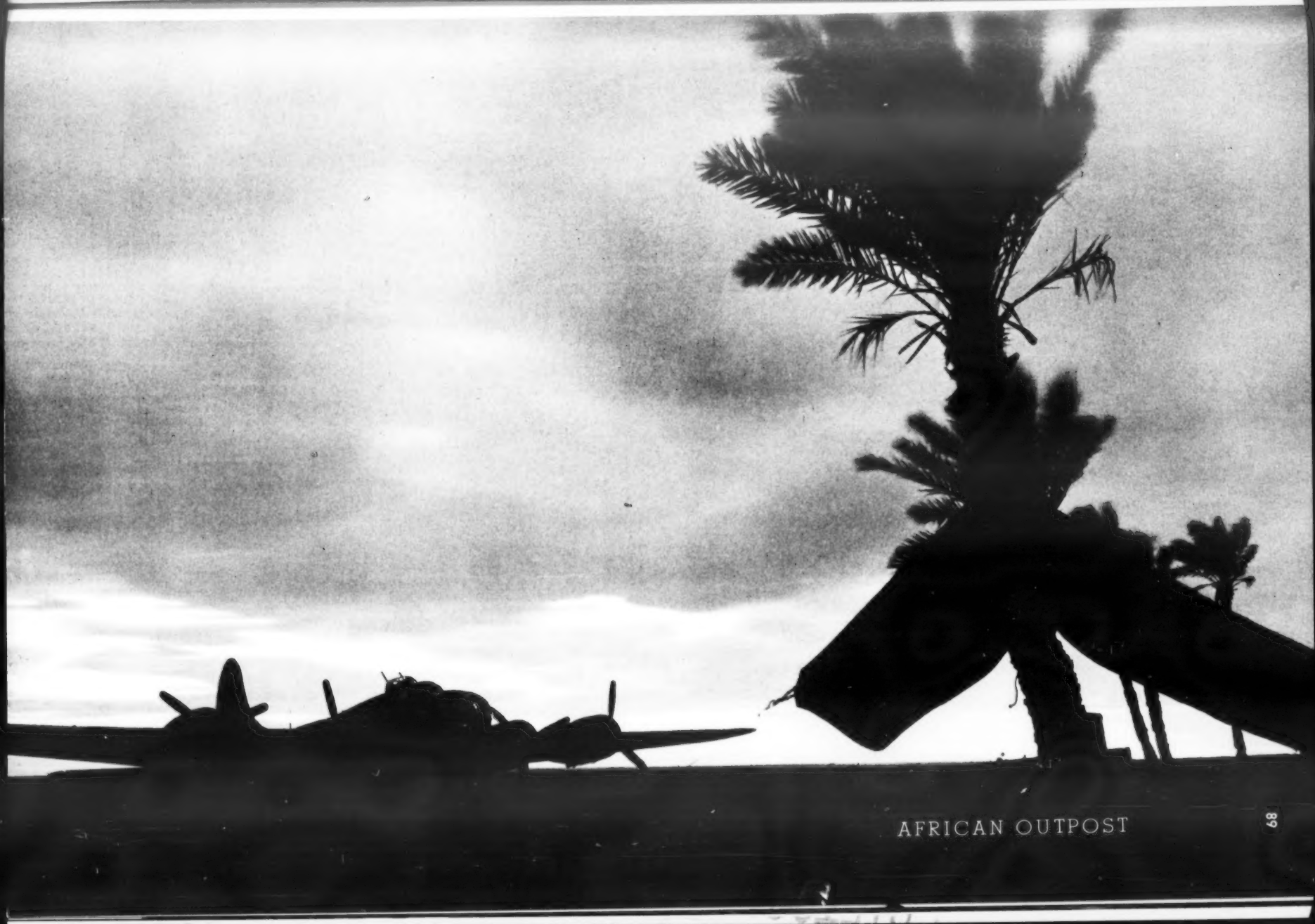
(*Continued on page* 344)

AAF *Album*

★ A selection of outstanding Air Forces photographs appears on the following pages

MARAUDERS





AFRICAN OUTPOST

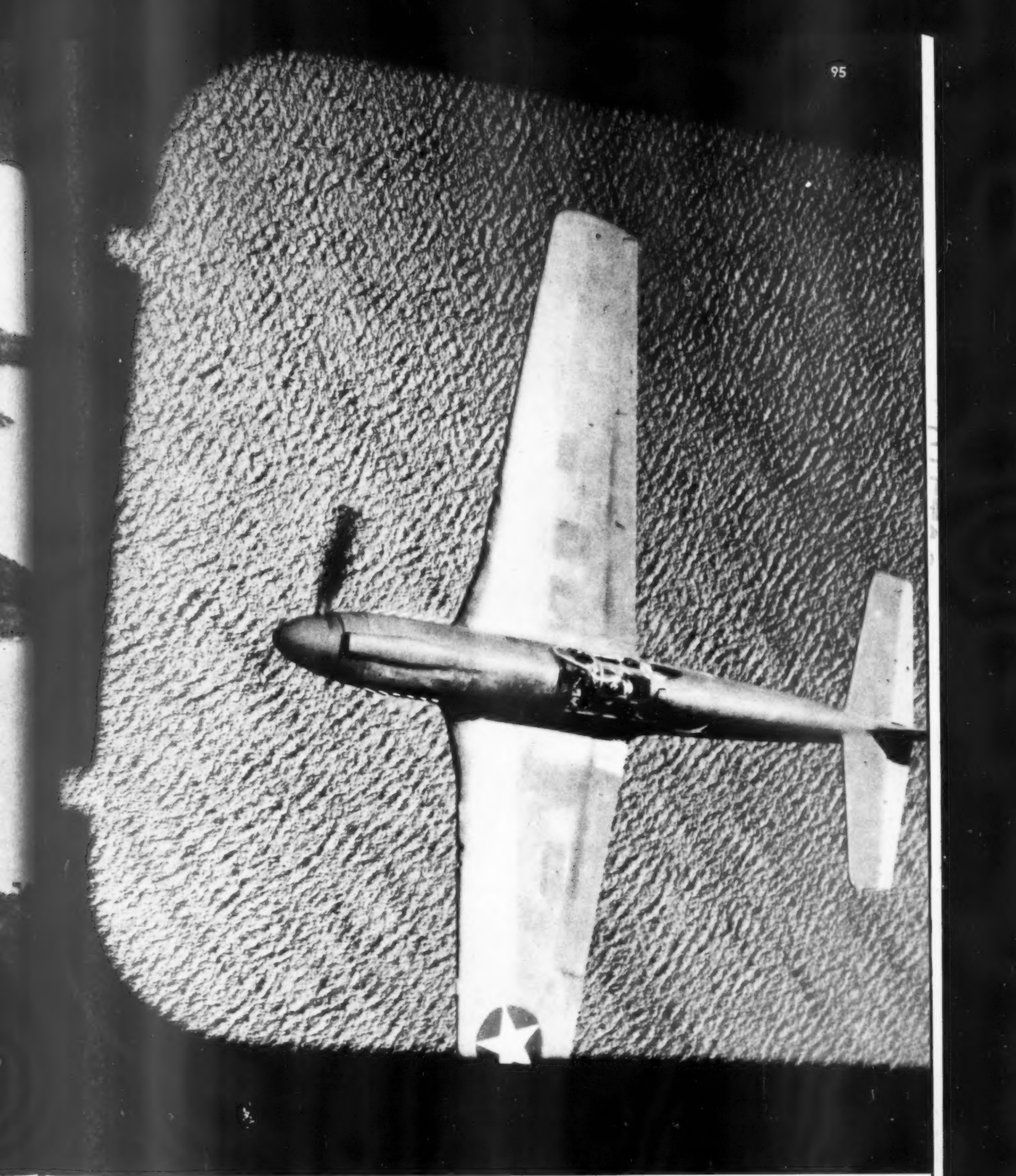
LIB

LIGHTNING

NURSEMAID

NIGHT WATCHMEN

"HELL'S BELLE"



MUSTANG

MITCHELL

LATE SHIFT

REMOVE DARK SLIDE
REMOVE DARK SLIDE
REMOVE DARK SLIDE
STUDIO

TOUGH HOMBRE

BROLLIES

AT EASE

The BOMBSIGHT

Giving the precision and accuracy of artillery, our famed bombsight enables the AAF to search out and hit the enemy far behind the front lines.

ONLY yesterday, accurate bombing was considered impossible. Ballistic data for ground weapons had been adapted to bombs and bombing theories. Mechanisms generally used gave only approximate solutions of the bombing problem. Comparatively simple mechanisms guaranteed fair accuracy at lower altitudes but not at heights above the effective range of antiaircraft guns. As bombers flew faster and higher the problem became very difficult. Only in the United States did anyone believe enough in the possibility of a solution to seek the answer. And they found it.

The airplane carrying bombs might well be compared with a gun platform, but it is an unstable and fleeting platform. It never remains in one place long enough for normal calculations of firing data. It moves rapidly in three dimensions as well as about three axes. The propelling charge of the projectile is gravity and the speed of the plane itself.

The problem was not easy. If the bombardier would mount his sight on a steady platform which moved smoothly along a level, straight line, he could use any of a number of known devices for accurately determining the point of release. But his platform is far from steady. High speed does not aid level, straight flight through normally rough air.

During a bomb's final trip to earth, three forces work on it. The actions of these forces must be calculated in a few seconds before its release and then used in determining the exact instant of release.

While the bomb is hanging on the shackle of the bomb-rack one force affecting it is the forward motion of the plane. When the bomb is released it has the same horizontal speed as the plane. Its inertia will maintain that same horizontal speed unless it is acted upon by other forces. A small boy, jumping off a moving car, senses this when he lands on his feet prepared to tumble or to run along with the car for a few seconds.

In a vacuum the bomb would continue to move at the same speed and in the same direction as the airplane at the time of release. If the bomber maintained speed and direction after "bomb away," the plane would still be directly over the bomb at the moment of impact.

The second major force, gravity, affects the bomb the instant it is released from the shackle. Its effect (if we again ignore air resistance) is easily calculated in terms of speed or of distance fallen at any instant after release.

Gravity works straight down. The bomb's original velocity works horizontally. By combining the two, we get the fundamental problem of a bombsight: how far down and how far forward will the bomb be after it has fallen a certain amount of time?

The third force, which we cannot ignore, is air resistance. We can streamline the bomb and give it fins which will keep it true (though some foreign air forces do neither very well), but air resistance is everywhere. Air acts to resist both other forces. It retards the acceleration due to gravity. Even more strongly, air lessens the horizontal velocity.

A freely falling bomb, starting from rest, will fall in a given number of seconds (t), a distance in feet (h), their relation being expressed in the formula:

$$h = 16.1\ t^2$$

If the time of bomb fall is 37 seconds, the distance fallen without air resistance would be $16.1 \times 37 \times 37$, or $16.1 \times 1369 = 22{,}040.9$ feet.

Actually, the best-designed bombs fall only a shade under 20,000 feet during that time. If the fins and body are true enough to give consistency we merely measure the time of fall

Bombsight mounted in the nose of a "Mitchell." Electrically-driven gyroscopes stabilize it against plane's maneuvers.

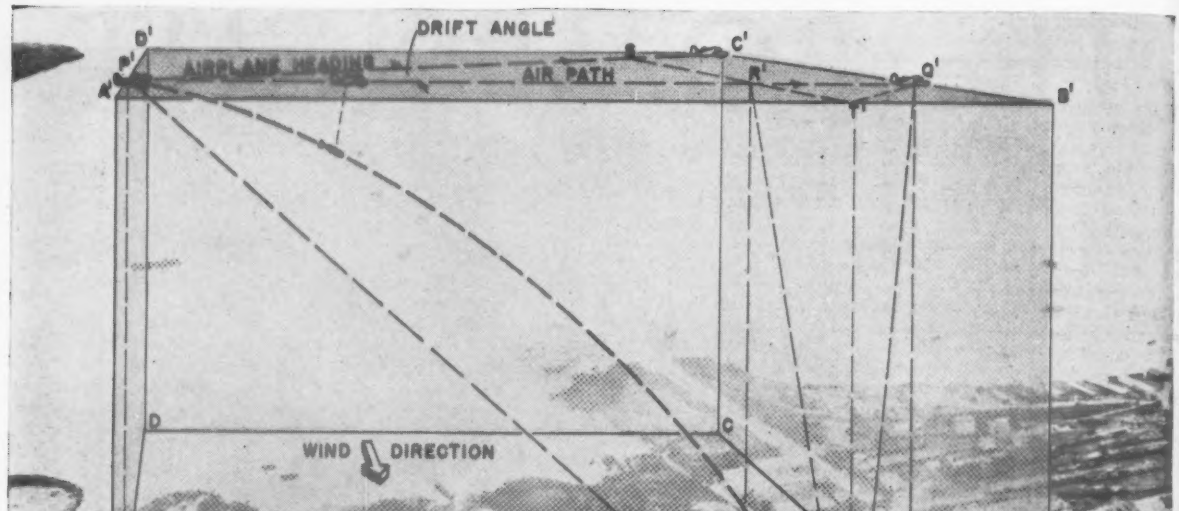
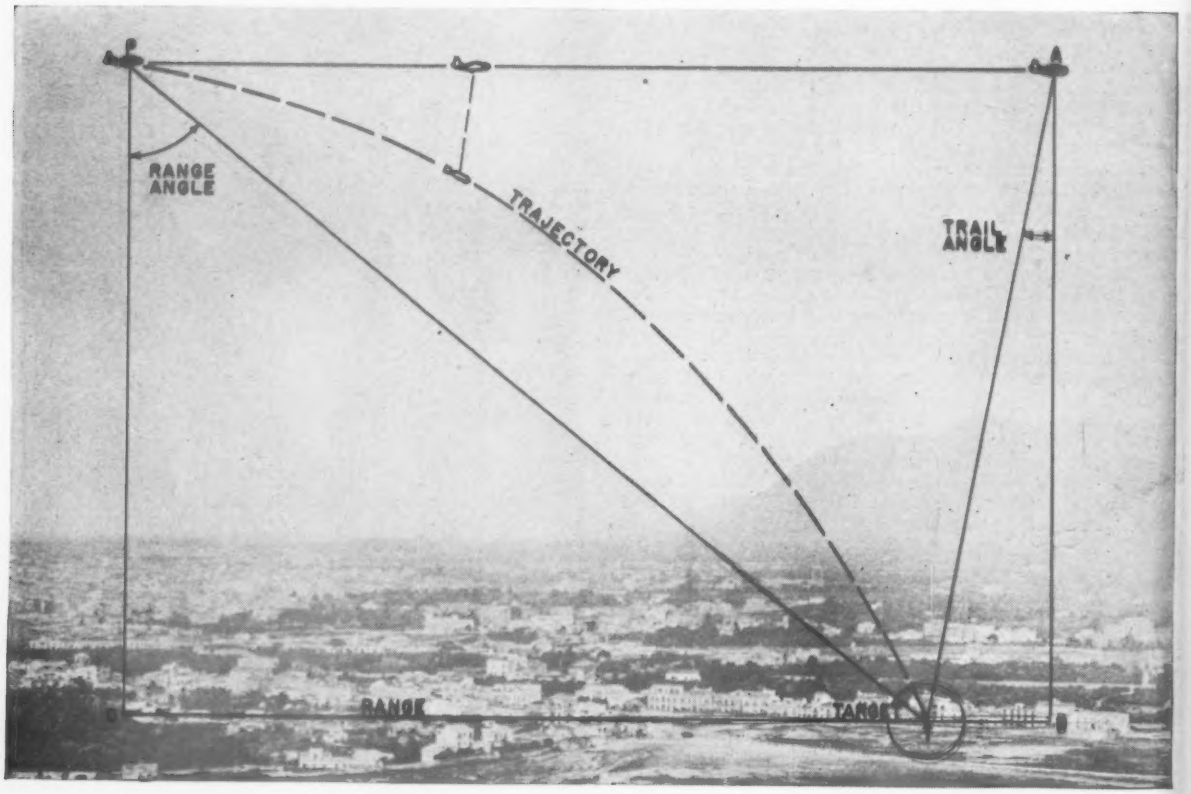


Figure 1. Bombsight is adjusted for cross-wind because block of air moving across ground track affects bomb trajectory.

Figure 2. This diagram helps to illustrate the operation of sighting mechanism with principle of two similar triangles.



from all altitudes in ordnance tests. Then we give the bombardier a table from which he gets the first setting on his bombsight—the actual time of fall from his altitude.

We noted that a bomb in a vacuum would stay directly below the airplane if the plane continued to fly straight and level at the same speed. If the plane were flying 200 m.p.h. at the time of release the bomb would move horizontally about 294 feet while falling only 16 feet in the first second. In the next second, the bomb would fall about 48 feet and would go forward about 294 feet again. The bomb follows a steadily steepening path downward. Air resistance retards horizontal velocity more than it slows the effect of gravity. Though the actual time of fall from 1,000 feet is eight seconds (nearly the same as in a vacuum) the bomb loses enough of its horizontal velocity to make it travel about 67 feet short of 2,350 feet which it would have gone at a constant speed of 200 m.p.h.

This lag is called "trail."

We measure this lag for each speed and altitude and give it to the bombardier in a table just as with the other data setting on his bombsight. We need only look at the target through the telescope and "track" it for a few seconds. The bombsight will do the rest.

But other factors must be solved either by the bombardier or by the bombsight. The most obvious are wind and target motion.

Consider first only wind, and let the target be fixed. Suppose the wind is constant—30 m.p.h. for example—all the way to the ground, and exactly "on the nose." If the bomber's airspeed is 200 m.p.h. it will move 2,350 feet *through the air* in the eight seconds that the bomb requires to fall 1,000 feet. In that same air "block," moving or still, the bomb will lag 67 feet behind the airplane in that time. But the air "block" is not still.

Instead, during eight seconds at 30 m.p.h., it moves about 350 feet in the opposite direction. Because the airplane and bomb were in the air "block," they were merely "carried along." Instead of traveling 2,350 feet *over the ground*, the airplane will move only 2,000 feet. The bomb, still falling 67 feet behind, moves 1,933 feet horizontally before hitting the ground. This horizontal distance moved by the bomb we call "range." It is one of the factors the bombsight must "calculate."

A 30 m.p.h. wind "on the tail" has exactly the opposite effect. The range is now 2,633 feet while the airplane moves 2,700 feet with respect to the ground. Data therefore is based upon true *air* speed and time of fall, while the bombsight must work on ground speed. Once we have set the trail and time of fall the bombsight must calculate ground speed and interpret it in terms of range.

That is the whole basic operation of a bombsight, which is fundamentally a ground speed meter.

Still more variations must be faced, however.

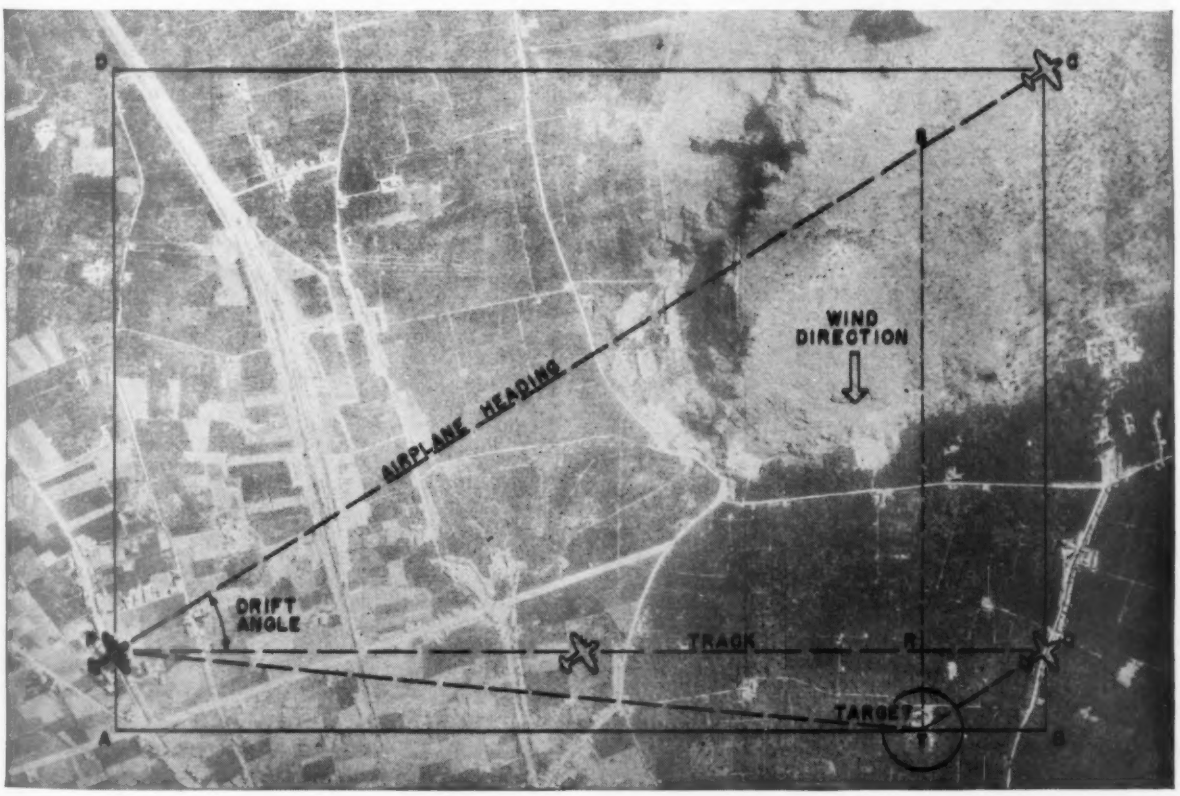
Before we consider more obstreperous winds—the kind that blow on almost every mission—let's bomb a target which moves in a straight line at constant speed of 30 m.p.h. in the direction opposite to that of the airplane.

During eight seconds the airplane will move 2,350 feet through the air which, we will now say, is not moving. But now the target is moving, *with respect to the air*, a distance of 350 feet in the same eight seconds. By combining the two distances, we see that the airplane "moves" 2,700 feet *with respect to the target*. The relative speed of the airplane and target is 230 m.p.h., the same as when the target was fixed and when the wind was blowing on the tail at 30 m.p.h. The bomb still lags behind the airplane 67 feet. Therefore, if we want the bomb and target to "connect," we must release the bomb on the same range, 2,633 feet, as for the tailwind conditions. Straight line target motion, we can thus see, has exactly the same effect as wind of the same velocity, but in the opposite direction.

Now notice what happens over the fixed target.

Consider a wind which is blowing at 30 m.p.h. directly across the ground track of the airplane. (See Figures 1 and 3). Obviously, in order to make good that track, the airplane must "crab." It does this by heading along the *air path* PC. Actually, it makes good that path *with respect to the air* and the bomb still lags behind the airplane the same amount as in still air to the point S, for example. But during that time the entire

Figure 3. Cross trail correction is made automatically when cross wind makes it impossible for bomb to follow ground track.



block of air has moved to the right over the ground, carrying both the airplane and the bomb, so that (on Figure 3) the airplane ends up at Q and the bomb at T, still the same trail distance *behind the airplane.*

Here we seem to have hit a stumbling block: The bomb does not fall on the ground track of the airplane. The airplane was headed across its own ground track and the bomb lags behind on a line extending the axis of the plane. At no time after release is the bomb over the ground track of the airplane. We must find some means for determining the offset necessary.

In earlier American sights, and today in most foreign bombsights this offset, which we call "cross-tail," was handled by a special setting. Yet offset is merely a function of trail (which we have already set) and drift angle. Therefore in our latest sight we have used mechanical linkage between the trail mechanism and direction control. The cross-trail correction is entirely automatic.

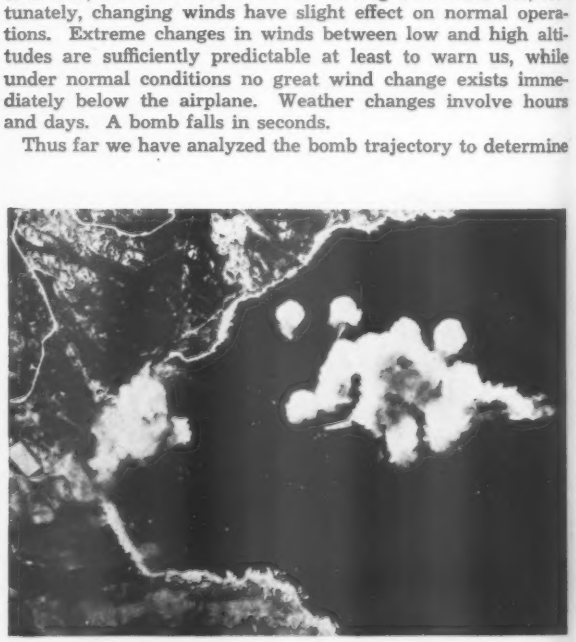
Target motion again has the same effect as a wind of the same velocity in the opposite direction. All of the factors are the same and they will be unchanged in principle regardless of the direction of the wind or target motion. A combination of wind and target motion does not complicate the basic picture or require any new settings. After the settings for trail and time of fall, the bombsight is concerned only with the resultant "closing" speed and direction of the airplane with respect to the target. It need not be concerned with the causes of the relative motion.

The wind, unfortunately, never is constant "all the way down." Any change in wind direction or velocity during the bomb fall will tend to spoil the moving air "block" theory we have pictured. As long as the bomb is moving in air which was "carrying" the airplane at the time of release, the only "wind" acting on the bomb is that due to its own motion. However, if a lower layer of air is moving slower or faster, or in a different direction, it will act upon the bomb in an amount proportional to the change in direction or speed and to the length of time during which the bomb remains in the new strata.

This has long been known as "ballistic effect." Changing winds along the trajectory are termed "ballistic winds" and their effect is calculable *if* the amounts and positions of change are known.

Yes, we can calculate and allow for the ballistic effect if we know the exact wind changes below. Over enemy territory, of course, we can seldom count on having exact data but, fortunately, changing winds have slight effect on normal operations. Extreme changes in winds between low and high altitudes are sufficiently predictable at least to warn us, while under normal conditions no great wind change exists immediately below the airplane. Weather changes involve hours and days. A bomb falls in seconds.

Thus far we have analyzed the bomb trajectory to determine



Sequence of destruction. On April 10, a group of "Flying Fortresses" from an armada of 88 demolished Italian cruiser Trieste, anchored behind torpedo boom at left. Above, bombs score hits.

the basic problem but we have not touched one factor which has defeated many otherwise excellent bombsight designs.

An airplane is free to move forward, side to side, up and down. It also rotates about three axes—one vertical, one through the wing, one through the fuselage.

To some extent, a plane moves and rotates regardless of its so-called inherent stability or of the pilot's skill. Because this is true, any reference line—such as a line of sight to the target —which is attached rigidly to any part of the plane will bounce around with every motion of the aircraft. Slightly better is a sight reference not attached to the airplane but controlled by a pendulum. Yet this type also is thrown about by any acceleration.

Changes in direction of such reference lines are normally as much as three or four degrees. Oscillations up to as much as 10 or 15° must be expected. These oscillations would make high altitude bombing completely futile if we desire to hit anything smaller than a whole city.

One degree equals approximately 17 mils, and one mil covers a distance of 25 feet on the ground when sighting from 25,000 feet. An oscillation of only three degrees while bombing from 25,000 feet would cause an error of 1,275 feet. Similarly, an error of three degrees in direction, maintained for 40 seconds in a 250 m.p.h. bombing run, would produce an error of 750 feet in location of the bomb release point. On the ground 25,000 feet below, this direction error would cause the bomb to strike over 1,500 feet to one side of the proper point.

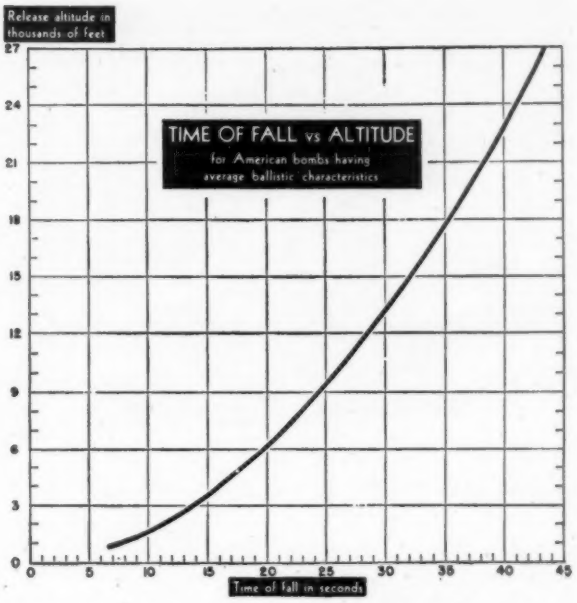
Bombsight inventors have tried two general schemes to stabilize their line of sight. The free pendulum idea was a slight help and the installation of dashpots (to dampen oscillations) further improved results.

The gyroscope naturally appealed to inventors' imaginations. Its chief deficiency is its tendency to change direction if an unbalanced force is applied to it. As long as a "perfectly" balanced rotor untouched by outside forces rotates at high speed it will maintain its axis for all practical use in a fixed direction in space.

How could air engineers apply the force needed to keep the rotor turning? Electric motors, with the armature being a part of the rotor, seemed to be the answer but early airplanes did not have entirely adequate electrical systems. It was easier to build and balance solid air-driven rotors, though not as easy to apply the air without causing torque. Such gyroscopes were the first used in bombsights, sometimes combined with the pendulum-and-dashpot feature. Now, however, precision has dictated the use of electrical rotors.

Next we had to control the stabilized line of sight without applying a force to the gyro. Obviously the line of sight must be controlled and this cannot be done without applying a force to the stabilized system. Yet such force exerted by normal means will ruin stability. It must suffice here to say that this problem has been completely solved in some sights.

Other engineers have believed the objective so impossible that even today they have not solved it. This is why certain bombsights are almost unbelievably accurate, while others, having only the partial solution, are satisfactory for little better than "scatter" bombing of areas.



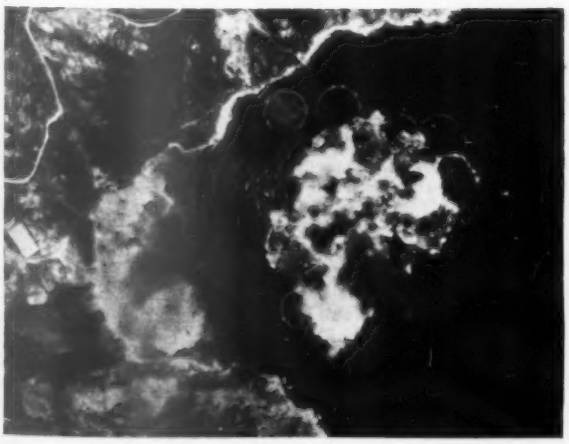
Calculation of time it takes bomb to reach target from a given height, shown here in graph form, is part of bombsight correction.

Air pioneers solved a further problem. Stabilization must be provided against oscillations around three axes, yet no one gyroscope can be used for stabilization with reference to more than two perpendicular axes. In the old, slow bombers, early bombsights that tried gyro-stabilization used only one gyro and that one had its spin axis vertical. But modern, high-speed bombing necessitates directional stabilization. Today the best sights add a second gyroscope with horizontal axis.

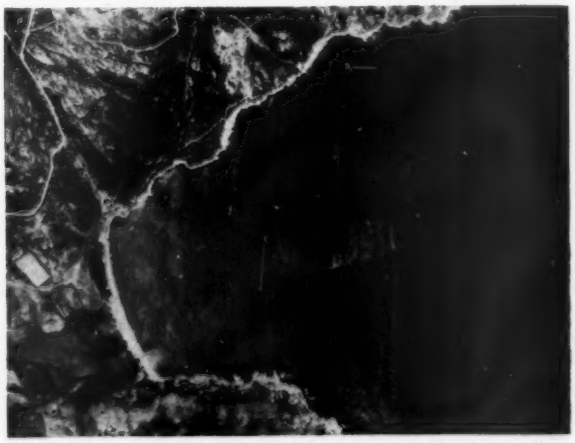
Except for the stabilization problem a bombsight is just another fire control instrument.

No one marvels very much about a cannon shooting accurately a distance of 15 or 20 miles, yet its shell travels under the same free flight condition as the bomb after release. In fact, a bomb released from an airplane traveling 200 m.p.h.

(*Continued on page 342*)



Here bombs blanket immediate target area. On the same raid, "Fortresses" also sank the 10,000-ton cruiser "Gorizia." The cruisers were anchored at the Italian naval base of La Maddalena, Sardinia.



Although the attacking flyers saw the "Trieste" rise at the bow and sink in the stern, the trailing bubbles carried by a current from the site of the sunken cruiser proved destruction was complete.

Boeing "Flying Fortress" (B-17F). Its thirteen .50 caliber machine guns make it the most heavily-armed airplane in the world.

THE BOMBER IS B

TO many an American, the Army Air Forces' heavy bombers are the "miracle" weapons of this century. Their matchless punishment of Axis targets has awed the man on the ground. Amazed at the hitting power of the *Fortresses* and *Liberators*, laymen often view the big bombers as a heaven-sent wartime development.

Airmen know better.

The bomber was born out of 20 years' hope and heartbreak. America's big bombers grew because an idea gave them wings. U. S. airmen call this idea precision bombing—the one method of leaping the enemy's outer defenses and blasting his industrial heart from the sky.

The big bomber was in many Air Forces minds even before World War I ended. Brig. Gen. William Mitchell believed his pilots could have bombed Germany to defeat had the war lasted into 1919. A few men saw the plane as a powerful new weapon. It could detach itself from ground bases, far beyond the range of artillery shells, and destroy the enemy's vitals.

The idea was ahead of the implements to give it striking power and the implements themselves were not equally developed. A crude bombsight appeared almost as soon as someone hurled a stick of explosive over the side. Yet until bombardment objectives were clear there was little reason to improve the planes and equipment.

U. S. airmen soon came to believe that the airplane could operate independently. They looked at the oceans and imagined war would come to America when an enemy battle fleet approached the East or West Coast. Air Forces planners saw a specific objective and the need for a specific plane—a land-based, long-range bomber to sink battleships. Only a big plane would have enough fuel capacity and bomb load.

The Army Reorganization Act of 1920 established the Army Air Service as the nucleus of the Air Forces that would lead the world in developing heavy bombers.

Air Service pilots in 1920 flew 9,000 miles from New York to Nome, Alaska, and return in four DeHavilland planes of World War vintage, thus pioneered the air routes of North America.

In 1921, the Air Service engaged in intensive bombardment training at Langley Field. Pursuit, observation and bombardment operated as a tactical team. The Navy turned over several captured German ships as bombing targets for Army and Navy planes. A joint Army-Navy board umpired the maneuvers.

As preliminary bouts, Army planes sank a German destroyer and, joined by Navy aircraft, the ex-German cruiser *Frankfurt*.

Sinkings of smaller craft boiled down to one issue: Could planes sink a battleship?

The *Ostfriedland*, once pride of the German Navy, had an underwater structure equal to the best United States capital ships of 1921. Six Martin bombers finished her in 25 minutes. The *Ostfriedland* rolled over, mortally wounded, and sank 60 miles east of the Virginia Capes.

Bombs of 2,000 pounds sank the dreadnaught, yet the Air Forces had 4,000-pound monsters available. Our policy always has been to use the smallest bomb that will do the job. Britain's famous blockbusters are nothing new.

Two months later, Army planes sank the outworn *U.S.S. Alabama* in Chesapeake Bay. Our planes on 1923 maneuvers smashed the battleships *Virginia* and *New Jersey* with a high percentage of hits from 11,000 feet.

The significance of sinking these outmoded battleships was not immediately clear but this much was certain: Five years after the Armistice, precision bombing had arrived. Now the Air Forces needed better planes.

A bad guess at progress was the Barling bomber. This was a great triplane, powered by six 400 h.p. Liberty engines, with an 11-man crew. The big, lumbering crate established endurance records, attracted the curious at air shows, merely proved a blind alley. It developed stiff joints and finally was scrapped.

Good airplanes were hard to find. Materials were flimsy.

"Liberator," teammate of the "Fortress." Despite the new B-29, airmen expect these two bombers to finish out the European war.

BORN—

The 1920's lacked the materials, engines and designs but they witnessed the formulation of bombardment policies that made the planes of the '40's possible.

Designs were wrong. Engines were heavy. The Barling engines weighed 1,100 pounds each.

Airmen spent the '20's looking for a bomber that would fly far and fast and clean.

As early as 1922, McCook Field, near Dayton, had a preview of the future. The Gallaudet bomber, a low-wing monoplane with a single engine, was defeated by two things: poor materials (the wing was built of sticks, wire and tape) and heavy engine.

Seeking monoplanes for better visibility and firepower, the Air Forces developed biplanes as stop-gaps. McCook pilots in 1925 tested the LB-1, a biplane with 66-foot wing span and one 800 h.p. engine—the first Keystone bomber.

The Engineering Division wanted more engines in order to maintain level flight with one engine in emergencies. And, the airmen added, more *powerful* engines, please. The year 1927 found Huff-Daland, Curtiss, Atlantic and Martin all feverishly building two-engined planes.

Men like Maj. Gen. Mason M. Patrick, Chief of the Air Corps, still thought progress was too slow. "We want something practical," he urged. "We do not want larger, or strategic, or night bombers. We want a bomber that is a bomber."

Specifically, Air Forces engineers wanted a plane that could reach 15,000 feet, cruise 300 miles at 125 m.p.h., and carry 2,000 pounds of bombs.

The Curtiss *Condor*, or XB-2, was a 1,200 h.p., twin-engined biplane. This biggest and fastest U. S. bomber of 1929 didn't excite the men who would plan the *Flying Fortress*.

"Our organization, training and policy," declared one group commander, "should strike the enemy air power at the roots and not among the branches."

Air power had sunk battleships (anchored and obsolescent). Flights to Alaska had spurred long-range planning. The Barling bomber had forced airmen to seek better materials than sticks and wire. A "perfect" bombsight had not yet been found. And training men to aim bombs was limited to tactical units. Plane designers still were bucking the problem of bombers to be "crated and shipped to our foreign possessions."

Yet Air Forces pioneers had come far beyond the "nuisance" bombing of World War I. The greatest thing they did in the '20's was to state the two aims of American bombardment:

1. Precision, because there were no planes, bombs or men to waste.

2. Long-range, because an invader must be stopped as far from our shores as possible.

The '30's were the years when the Air Forces actually put these two aims to work by better planes, finer precision instruments, improved bombs and highly trained manpower.

The most pressing need of Air Forces planners, as they took stock in January, 1930, was a bomber that could keep war out of America. Wright Field research pointed toward one basic type: an all-metal low-wing monoplane, multi-engined for staying power, a land-based plane able to fly hundreds of miles over water if necessary, drop its bombs and return home.

The American bomber was open to bidders.

Henry Ford made the first offer—an all-metal, high-wing trimotored plane. Boeing at Seattle submitted its Model 215 as a "heavy" bomber. Keystone, Fokker, Martin and Douglas also were busy.

In test flights, air officers found Ford's design "basically at fault," the Boeing bomber "a remarkable advance." Then the Air Forces flew Martin's experimental B-10. In it America owned the world's fastest and most powerful low-wing, all-metal, twin-engined bomber—the successor to the famed old Martin of 1921 that had dropped the "bombs heard 'round the world" and sunk the *Ostfriedland*.

Air Forces doctrine defined Army aviation's *primary* mission as bombardment. Airmen wanted a twin-engined monoplane that could carry 2,000 pounds of bombs and fly 200 m.p.h. in a 400-mile radius. The B-10 came nearest the mark and Martin won the bid.

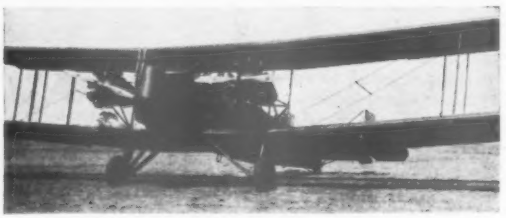
Foreign nations, equally shrewd at bargains, were keen to

15 YEARS OF AAF BOMBERS

DeHavilland DH-4, principal equipment in early '20's.

Martin bomber, carrying a 1,650-pound bomb, in 1921.

Huge Barling bomber. Triplanes proved a blind alley.



Keystone LB-6, twin-engined biplane, was only a stop-gap

Boeing B-9, twin-engined bomber presages today's design.

Martin B-10—an outstanding success when it joined AAF.

buy the B-10. The War Department refused offers from Britain, Russia, France, Japan and Turkey for a year, then permitted debt-worried Glenn Martin to sell his bombers abroad minus guns or other "interesting" equipment.

In early 1934, Maj. Gen. Benjamin D. Foulois, Chief of the Air Corps, ordered Wright Field to standardize the B-10 immediately. Air pioneers negotiated with Martin and Boeing for *real* bombers.

The air chiefs rounded up 10 tested B-10's and took off from Washington on the now historic Alaskan flight of midsummer, 1934. Then—Lieut. Col. Henry H. Arnold, now commanding general of the Army Air Forces, led veteran pilots in the most thumping proof yet of long-range planes. The Air Forces suffered no loss of ships or personnel, repaired their aircraft in the wilderness, surveyed much of Alaska for future bases.

The Martins climaxed the Alaskan adventure by flying nonstop from Juneau to Seattle, 943 miles over water in 5 hrs. 40 min.

Alaska's strategic nearness became a fact.

American airpower could defend the territory. Enemy air power, based on Alaska, could attack the United States.

Kinks in the B-10's were ironed out in Martin's B-12, the best long-range military plane airmen had in 1934. The B-12 was still serving the British over Africa in 1940—a long run for any airplane.

Prior to 1935 the big-bomber champions had little more than faith to guide them. In 1935, however, two momentous things happened.

First, the GHQ Air Force was established.

Second, the first *Flying Fortress* was test-flown at Wright Field.

American air power was designed to halt invasion, and bombardment in 1935 was visualized in these terms:

Daylight operations, for visibility.

High-level flying, for safety from surface guns.

Formation missions, for maximum effect.

Highly-trained crews, for economy of effort.

Fast, well-armored, heavily-gunned planes, for independence of supporting aircraft.

Precision bombsight, for accuracy.

All-weather security, for all-weather missions.

Long range, for hemispheric strategy.

These demanded a big plane, but size was incidental—the result of more fuel, more men, more bombs, more engines.

Maj. Gen. Frank Maxwell Andrews, a lieutenant general at the time of his death in the European theater, took charge of headquarters at Langley Field, Va., and around him he gathered the nation's top air strategists. One bombardment and pursuit wing at March Field, Calif., was commanded by the present chief of the Army Air Forces, Gen. Henry H. Arnold. Another bombardment wing, under Brig. Gen. Conger Pratt, was based at Langley. Pursuit was concentrated at Barksdale Field, La. Wright Field remained the Air Forces' laboratory at Dayton, O.

GHQ strategists immediately launched a 10-year program of bigger, faster, longer-ranged bombers.

A few weeks after the GHQ Air Force set up shop, Boeing's Model 299—not yet called the *Flying Fortress*—flew out of hiding at Seattle. This four-engined, midwing monoplane weighed 16 tons, had a 104-foot wing span and performed brilliantly in preliminary tests.

On October 30, 1935, air officers filled Wright Field with hope and nervousness: the Boeing XB-17 was to fly officially. Maj. Pete Hill, chief of the Flight Testing Section, warmed up the engines of the huge aircraft. The tail controls were too big to operate unless the slipstream from the engines was blowing into them. On the ground, spring locks gripped these controls until the pilot released the locking pins.

Hill eased the brakes and the XB-17 began to move. Just as he gunned the throttle, Hill pulled the lever to unlock the tail controls, which froze. Rigid and helpless, the bomber rose at a sharp angle. The ship stalled, then crashed and burst into flames. The co-pilot escaped to tell what had happened. Hill and a Boeing engineer burned to death.

Boards of inquiry found Boeing, the Air Forces and Hill equally blameless. *The Air Forces ordered 13 more B-17's. Up from the ashes of that first model, the Flying Fortress rose on faith, guts and hard-headed planning.*

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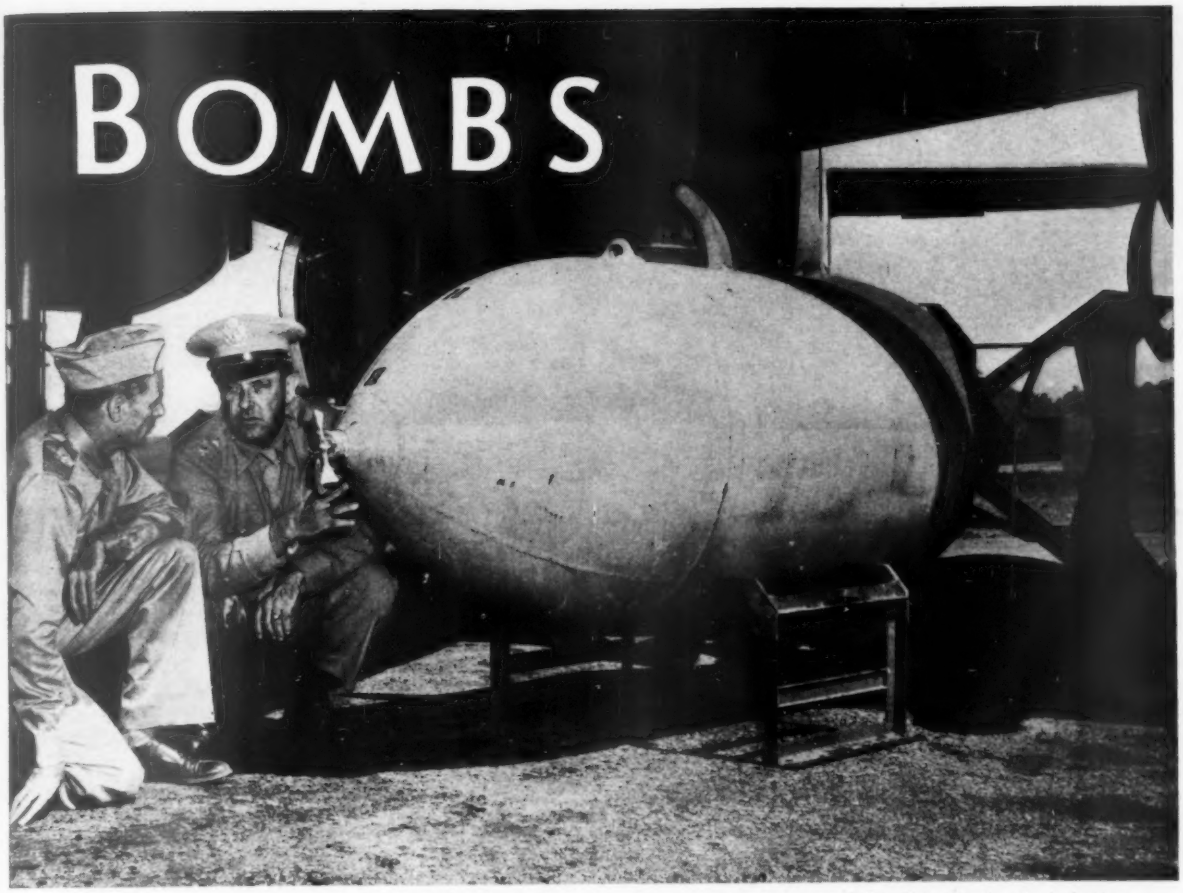
BOMBS



Brig. Gen. G. M. Barnes and Maj. Gen. L. H. Campbell, Jr., chief of ordnance, examine 4,000-pound demolition bomb prior to testing.

The AAF chooses bomb designs for specific types of offensive missions as carefully as the aircraft engineer designs his plane.

BOMBS of the Army Air Forces are pounding out the shape of victory. Air offense has proved to be the most effective power unleashed in World War II.

From the beginning, the AAF has understood the aerial bomb as an offensive weapon. The Ordnance Department, with the Air Forces, has developed, tested and proved every type of bomb, studied the suitability of each to a given mission, observed their power and effectiveness, and generally kept pace by fitting bomb designs to the bombing potentials of plane types as they evolve. Today we are delivering those bombs—the most efficient in the world—straight to the enemy.

What is a bomb?

Ordnance Department defines it as a missile intended to be dropped from aircraft.

Five kinds of bombs are used by the Army Air Forces today: (1) demolition, (2) fragmentation, (3) chemical, (4) practice, and (5) drill and gauge. Of these, the first three types are the only ones used in combat.

Should the target be such that it is necessary to expend a tremendous amount of energy within it or against it—that is, to blast walls apart, to burst a hole in a ship, to excavate the foundations of some structure, or to crumple a dam—then demolition bombs are used.

A demolition bomb is really a balanced, streamlined package carrying a charge of high explosive to the point where it can be used best. It is housed in a bomb body, or case, which is made light and yet strong.

The bomb must remain in one piece until it detonates, gen-

Fragmentation bombs rain upon a Sardinian airfield. Airplanes the size of a "Liberator" can carry 192 such 20-pound bombs.

Armorers hastily fasten bombs to external racks of North American "Mitchell" during height of Tunisian campaign.

erally within the target, instead of breaking open on first impact. In order to obtain the penetration necessary for different targets and still carry the maximum amount of explosive, demolition bombs are made from several different metals of varying hardness and varying case thickness. They are divided into the following types:

GP—General purpose .....50-55% explosive
SAP—Semi-armor piercing ..... 32% explosive
AP—Armor piercing ..... 5-12% explosive
LC—Light case ..... 77% explosive
DB—Depth bomb .....70-75% explosive

The GP bomb is made of such strength that it can be dropped without rupturing against a concrete slab four feet thick from an altitude of 8,000 feet. Using a delay-action fuse, bombs of this type would crash through to the basement of most buildings, bury themselves several feet in the ground near a bridge or penetrate the deck of any seacraft except cruisers and battleships.

The GP bomb is made in five sizes:

1. The 100-pound bomb can demolish a two-story building, wreck a locomotive, gun installation, or other machinery from 10 feet, damage an airplane from 75 feet.

2. The 250-pounder will destroy walls and floors of all buildings except skyscrapers, will sink or severely damage all seacraft—except battleships and cruisers—as far as 20 feet away, tear up railway tracks for a distance of 30 feet.

3. The 500-pound bomb will cause 75 feet of concrete dock to collapse from 25 feet away, will wreck steel railway bridges and subway passages, sink or seriously damage light cruisers as far away as 25 feet, and demolish most tanks.

4. The 1,000-pound bomb can displace the piers and spans of the heaviest bridges.

5. The 2,000-pound (one ton) bomb will crack or burst a large hole in dams, sink or seriously damage modern battle cruisers and battleships when direct hits, or as far as 35 feet away when exploded in the water.

The Laboratory of Wartime Operations has produced a mathematical formula on the underwater effect of GP demolition bombs.

Pressures of four tons per square inch are required for hull rupture of surface vessels of the most modern construction. That is, there is a danger area around and under a vessel, depending upon the size of the bomb, where hull rupture and consequent sinking will occur.

There is a larger area in ratio of magnitude of about 1 to 80 of shock limit that will have little effect on outboard fittings. Persons within that water area, however, will be killed or seriously injured by the shock of the blast.

Truly a general purpose bomb, the GP can be used most effectively against nearly every type of military objective by using the proper tactics. It can be used by the AAF, the U. S. Navy and the RAF. It can even split the sides of a submarine on detonating at the proper depth. This is accomplished by using a delayed-action fuse or the Navy's hydrostatic fuse.

To blast the vital organs of targets which the GP will not penetrate, semi-armor piercing bombs were developed. They are made in sizes of 500 and 1,000 pounds. The heaviest tank can be punctured by the 500-pound semi-armor piercing bomb while the 1,000-pounder will penetrate the side or deck of all naval craft except battle cruisers and battleships.

Seacoast mortar shells have been converted and adapted with fins as armor-piercing bombs. These bombs are generally capable of penetrating the armor of battle cruisers and battleships, and a direct hit exploding within the ship will cause serious damage. This type is not generally used since the explosive content is so small that a near miss will have negligible effect.

On the other hand, a 2,000-pound GP bomb will do considerable damage as far as 55 feet from a battleship. The various weights of AP bombs are 699, 800, 900, 1,000, 1,400 and 1,600 pounds.

Tamping produces the maximum destruction in an explosive. The destruction caused by a well-tamped explosive may be

At an Aleutian base, ground crew of 11th Air Force loads bombs into fuselage of a "Mitchell."

4.5 times as great as the same amount untamped. To the bomb expert this means the explosive must be confined *within the target.* There must be no holes through which its energy may escape. To accomplish this the bomb is made to penetrate a building, the ground, a ship, or the water beside the ship.

With the light-case bomb, no penetration can be obtained. The case will rupture and spill the explosive on impact with practically all objects except water. Then why use it at all? The light-case bomb was designed for a target that provides its own tamping—a congested city block. The "block-buster" has 3,362 pounds of explosive cast into a bomb weighing 4,200 pounds and equipped with an instantaneous fuse so that the terrific blast will occur before the bomb case ruptures.

Our planes patrolling the seas surprise the enemies' submarines continually. To knock out the U-boat, the maximum blast must be delivered to the proper depth. This is accomplished by one of two depth bombs, the 325-pound Mark 17 and the 650-pound Mark 29. These bombs are of very light case, having about 75 per cent explosive filler and a Navy hydrostatic fuse. The operation of the fuse depends upon the pressure upon it and consequently its depth below the surface. The depth may be pre-set.

A second kind of AAF bomb is the fragmentation type used against ground forces and light material—trucks, airplanes and encampments. Its destructive power results wholly from fragmentation of the bomb case. Fragmentation bombs have

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Looking like a torpedo, this large bomb is slung on a special external rack on a Martin "Marauder."

THE MEN

Aviation cadets hold the spotlight, but pilots actually are only a small proportion of essential Army Air Forces personnel.

Successful use of personnel classification methods enables the AAF to fit untrained civilians into 450 occupations in our 2,200,000-man Air Forces.

SINCE midsummer, 1941, the Army Air Forces has become a giant weapon of attack whose soldiers can strike at the enemy with tremendous speed and devastation. A scant two years ago the AAF had fewer than 10,000 officers, 9,000 cadets and 126,000 enlisted men. Today its strength has reached 2,200,000 and is still growing.

Creation of this vast organization solved an unprecedented problem: mass transfer of manpower from civilian life to highly specialized military aviation.

Before Pearl Harbor, our plans of manpower procurement, induction, enlistment, classification, training, assignment and morale dealt in terms of thousands. Now we deal with millions.

Whenever a heavy bomber takes off against an enemy target more than 30 men are directly involved, with fewer for the smaller types. Each is an expert in maintenance and operation of combat planes. Hundreds of others—the air base troops, the operations staffs, the supply men, the engineers, the ordnance crews—contribute to the success of each mission.

On the basis of a 2,000,000-man air force, this means the training of some 185,000 pilots and hundreds of thousands of bombardiers, navigators, ground officers, radio men and mechanics. Today's Army Air Forces requires 450 different technical and occupational skills.

Building this air power forced drastic changes in manpower procurement. The Army Air Forces once preferred college men for aviation cadets. Peacetime airmen assumed that Army aviation's highly technical courses required college background. But war's demand for new pilots changed minds. Now we know that a peculiar aptitude and skill born in crack combat flyers is what is needed. Men who never finished high school often have it.

Regardless of education and social background our combat pilots are America. They are the neighbor's boy, the shoe salesman, the grocery clerk. They are last year's football hero, or, like Colin Kelly, young men from West Point. All that the Army Air Forces asks of them is the will and ability to fly our modern warplanes.

The Air Forces is calling to active duty thousands of young men who had enrolled in the enlisted reserve for aviation cadet training. These men are now receiving pre-flight training at various colleges and will be admitted to the pilot schools as quickly as facilities permit. As our aircraft output increases, thousands more will be inducted.

Meanwhile, the Army Air Forces has trained a vast army of technicians—mechanics, communication experts, meteorologists, radio operators, armament workers and other specialists. Generally, their intelligence quotient has been slightly higher than the average soldier level. The Army Air Forces wants only those who give reasonable assurance of absorbing the technical and mechanical instruction.

Their ages range from 18 to 45 and only the barest handful knew the difference between an aileron and engine nacelle when they first reported.

Like the pilots and combat crews, Army Air Forces ground troops have proved themselves under fire. In the bomb-shattered air fields of Bataan a few valiant men kept battered P-40's flying to the end with little more than baling wire, determina-

tion and the application of that well-known Yankee ingenuity.

Men on the ground are winning the battle of supplies. At remote outposts they had no lathes at first, no pneumatic riveting machines, no skins for patches, no bearings, no motor parts. Yet they kept our planes in the air. They rebuilt bombers between dusk and daylight with improvised tools and materials salvaged from wrecks. And most of them had never seen the inside of a machine shop until they joined the Air Forces.

To skeptics, ground crews have proved how wisely Army classification works.

Classification of raw recruits had its beginning in 1917. Our present system is still far from perfect. By and large, however, Army Air Forces permits the men to choose their jobs. No soldier who has the makings of a radio mechanic is going to find himself behind the skillet of a mess kitchen. But if a garage mechanic prefers pots and pans to monkey-wrenches he'll probably get his chance. The AAF needs cooks, too.

Another personnel problem has been the mobilization of thousands of administrative and technical officers at home and abroad. AAF wartime expansion called for an immediate supply of officer strength until enough soldiers could be selected from the ranks for training and commissioning.

The most direct method at the outset was to commission civilians with specialized talents that could be used by the Army Air Forces. Most of these men were immediately dispatched to an indoctrination school at Miami Beach for six weeks of physical and academic training. As hundreds of thousands of enlisted men were absorbed by the Army Air Forces the practice of commissioning civilians was sharply curtailed.

Now virtually every newly-commissioned Air Forces administrative officer is a product of the ranks. Leadership traits marked him for Air Forces Officer Candidate School. There he had to prove himself true officer material.

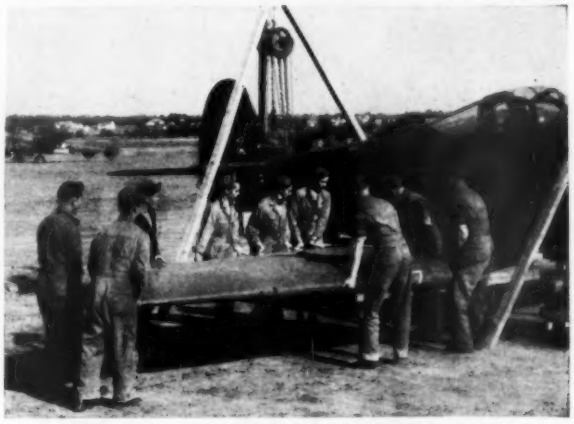
Today the AAF has crossed the major manpower hurdles. We no longer are recruiting aviation cadets for training as armament, communications, engineering and photographic officers. The flow of enlisted personnel into the Air Forces technical schools continues unabated.

Personnel priority No. 1 just now is the bomber's combat crew—the pilot, the aerial gunner, the bombardier and the navigator.

In this war of techniques and world battlefronts, the Air

(*Continued on page* 236)

Like all AAF specialists, gunnery students shown here were carefully selected by personnel classification tests.



AAF ground crews learn to do their jobs swiftly and well. Here wing repair crew puts a new wing on an "Airacobra."

Bomber crew shoulders equipment and heads for rest after training flight. Ground crew is already checking the plane.

Air Support seeks to disrupt the enemy's communications and supplies, and, in spectacular form uses guns and bombs to attack him directly in support of our ground troops.

Carrying ammunition and guns for simulated attack against the "enemy," air-borne troops deploy from Douglas "Skytrooper."

AIR SUPPORT

IN a certain broad sense, all air action is air support. All of it must co-ordinate with the Army and the Navy in the primary object of imposing our will upon the enemy. But the uses of unaided air power, such as in the strategic bombing of industrial Germany and France and in the development of our long range Air Transport Command, are discussed elsewhere. No action with enemy ground troops is involved. Strictly speaking these very necessary parts of air power are not air support. Neither are the activities of our coastal patrol and fighter defense elements. The latter are merely designed to counter the same kind of strategic activity we are now pressing home on Germany.

Air support is ideally exemplified in our Sicilian, African and New Guinea campaigns, which will long stand as examples of the close co-operation in actual combat on land, sea and air, that brings victory quickly and with minimum casualties. Air Transport Command's global lines and our effective anti-submarine patrols from the air enabled us to muster the strength where we needed it. Our strategic bombing of German industry and Japanese communications weakened the enemy in that respect at the moment of contact. But the organization and operation of those air elements which actually supported the ground troops was something else.

A theater commander, such as General Eisenhower or General MacArthur, may have one or more Air Forces assigned to his use. Such an Air Force may include heavy bombers, medium bombers, fighters, observation planes, transports, liaison planes, photo reconnaissance and special types. The needs of each theater determine the types and proportions of planes assigned. The heavies and mediums and the torpedo planes will be used to carry on the strategic bombing of industry, communications and supplies right up to the dumps in the enemy's rear spheres of action.

Then comes the phase of indirect air support. This is aimed at isolating the battleground from the enemy's own support areas. It prevents him from bringing up troops and supplies to reinforce the units in actual contact with our forces. This type of support is usually combined with fighter patrols over the battle area to prevent the enemy's air forces from harassing our own rear. If this is done properly, our ground forces are left free to deal with an enemy rendered incapable of sustained effort.

This is perhaps the least spectular form of air support. Yet it is the most frequent, the most profitable and the lowest in air casualties.

The medium, light, dive and fighter bombers are its mainstay, though heavy bombers have been used in these tasks. The air commander and the ground commander must work closely in this type of action. The ground commander merely defines his wishes in broad terms to the air commander, leaving him free to employ suitable and available units under general mission type of orders, in the manner he believes will be the most effective. Thus heavy striking power can be developed at the most essential points, and commanders can avoid that bugaboo of air support, the tendency to fritter away air power by breaking it up into numerous small forces directed against lesser targets.

This is the kind of air support most generally given by the Army Air Forces in Africa and in the Southwest Pacific. As we closed in on Tunis and Bizerte, however, as we invaded

Troops load heavy airport machinery aboard Douglas "Skytrain" during drill at Westover Field, Mass.

Sicily, as we crossed the Owen Stanleys and worked up the shores of New Guinea; as we pressed our attack on Munda and the Aleutians, the most spectacular kind of air support came into play.

This is the kind the boys on the ground can see and feel. It is the direct employment of our air-borne guns and bombs of every type to blast out enemy strong points, attack enemy armor engaged with our own troops, and bomb and strafe enemy infantry. The bombers get at concentrations beyond the range of our own artillery; skip bombing attack planes and fighter bombers slash into the very front lines, and once the break-through comes, the whole weight of the air is used to disorganize the enemy's retreat into the kind of rout that forced whole German and Italian elements to surrender en masse.

Nothing so lowers enemy morale as this type of attack, particularly where troops have not been hardened to it. Conversely nothing so raises the morale of our own men as to see friendly planes bombing and strafing their opponents. But this attack is difficult to co-ordinate precisely and its cost in any event is relatively high in air casualties compared with the actual damage inflicted on the enemy. Its morale effect is so important, however, as to justify its frequent employment despite the comparatively high casualty rate.

The tactical air force for these purposes usually consists of a Fighter Command, a Bomber Command, a Base Service Command and an Air Support Command. The air support includes reconnaissance, which is the classical and time-honored function of military aviation. Reconnaissance may be either tactical or strategic, with photographic planes generally used for the latter in order that the command may lay its long range plans. But in battle itself there is no time for photographs. Information must be conveyed rapidly to headquarters through fast fighters and bombers and it must be just as rapidly distributed. Hence air support usually includes signal troops for laying wire, installing teletypes, setting up radio circuits and other communications.

Air Support Command, because of the vital need for instant co-ordination, is located at Army Headquarters. Air Support controls are at corps headquarters and Air Support parties at division. When a division commander encounters resistance that he thinks can be cracked from the air, his Air Support party officer makes the request to corps. There the project is quickly evaluated by air and ground staff officers as to whether (1) the target is suitable, (2) necessary aircraft are available and (3) the target is in a sector given priority for air action by higher authority. If the project measures up on this scale the Air Support control officer orders air units of his selection to perform the mission and at the same time notifies the unit requesting this action that it is coming and precisely when to be prepared for it.

These are the tactics used in Africa. They were notably successful at the Kasserine Pass, where, with the assistance of the ATC and the Troop Carrier Command, our thrust was sent home faster than the Germans could prepare to meet it. Men and supplies were actually landed far in advance of Axis pockets of resistance before our ground troops could mop up. They were landed actually within "spittin'" distance of unloading German transports that were subsequently pounced upon and destroyed.

The ATC, of course, seldom gets into the battle zone. It covers the far-flung air paths of the whole world on its transport missions. But the Troop Carrier Command takes on where Air Transport leaves off. In Sicily, for instance, it staged a truly startling demonstration of air support. Gliders and transports carried the paratroopers and the specially trained glider troops that had many of the enemy strong points of resistance along the beaches and the adjoining hills and roads in our hands before the enemy command could determine where our landing forces were coming.

The Italians had been building pill-boxes and artillery positions to protect those southerly beaches of Sicily for more than three years. Our men from the air had them well in hand in not much over the three hours by which they preceded the men from the landing barges. Those men in the landing barges would have paid a terrific price in casualties

had not our men from the air already silenced the Italians' protecting guns.

Their next function, as it had been in the African advance, was to seize airports and enable other transports to land with the bulldozers, scrapers and steel mats that soon had the airports ready for our fighters and strafers, though but a few hours before our bombers and naval guns had made them unusable by the enemy.

It has now been revealed that a whole air-borne division took part in the Sicilian invasion. Once on the ground they were completely self-supporting. They were even accompanied by their own medical officers.

Another large element of that division was landed in gliders. We can be sure that they came in shooting. And we can be sure that this new type of pilot could set his shooting glider down on any patch of undamaged airport, into a wheat field or near enough to the edge of an olive grove to end his taxi run comfortably under the protection of the trees. Full evaluation of the work of the air-borne division has not been made as these lines are written but every report from the battle-front indicates that they more than pulled their weight in the first successful crack in the walls of the crumbling "Fortress Europe."

Though, as has been said, the bulk of air support in the Pacific was of the indirect sort, the battles of New Guinea could not have been fought without both direct and indirect help from the air. The most notable example of indirect air support was, of course, the Battle of the Bismarck Sea in which Army bombers, unaided, sank 22 Japanese warships and transports and wiped out an entire division of 15,000 men at trifling cost to themselves.

Directly, however, our air forces have long given strong support to the Australians on the New Guinea mainland.

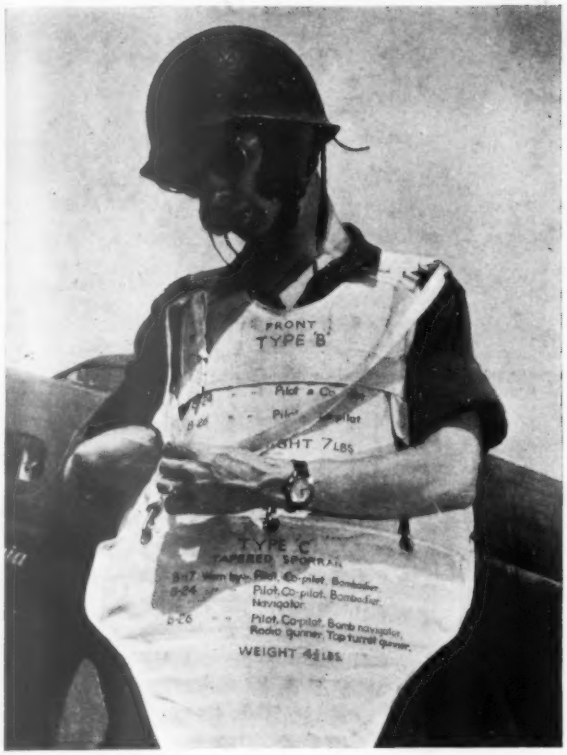
"Even before I left there," said one officer, "we were closely supporting the Australian ground forces when the Japs were still coming over the Owen Stanley range. The Australian commander himself told me that if it hadn't been for our Douglas *Havocs* the Japs would have taken Port Moresby. We hit them every morning and every evening with the *Havoc's* forward guns and fragmentation bombs. The Australians couldn't praise them enough. It was a kind of morale builder for them—and a morale scourge for the Japs."

As the battle progressed and the Japs were driven over the mountains and up the northerly coast, air support became even more important. Food, medicine, supplies, ammunition, replacement troops—even 105 mm. guns—were carried over the mountains to the battle lines. And on the return trips of the big cargo planes hundreds of wounded were flown out to the prompt care of base hospitals. Without that care many would have died. Literally millions of pounds of men and material were carried by air. In one week alone 30 airplanes carried 312,000 pounds.

Guadalcanal's early days are full of stories of direct air support achievement. On one occasion nests of Japs in caves and under the overhanging banks of a ravine were holding up the entire advance. From Henderson Field, almost in sight of them, a squadron of Bell *Airacobras* was sent up with instantaneously-fused bombs beneath their wings. They dropped them into the ravine where the artillery couldn't reach. The detonations within that enclosed space enabled our men to walk on without important opposition.

From that isolated instance of the use of a few fighters on Guadalcanal to the employment of a whole air-borne division in Sicily, air support is developing. A British veteran of Dunkirk declared the other day: "Had the Germans after Dunkirk known one-tenth of what that air-borne division of yours knew in Sicily, I shudder to think what might have happened in the Battle of Britain." END

Paratroopers saw action on a large scale for the first time when an entire airborne division helped to invade Sicily.



Steel vests deflect .30 caliber bullets, .37 mm. flak.

Pilot-seat armor stops .30, deflects .50 caliber bullets.

DEVELOPING THE TOOLS

War in the air has accelerated aircraft and equipment development a hundredfold. This is the story of how many of today's fighting tools came into use.

DURING war, all development skyrockets. The need to do a thing quickly pressure-feeds new ideas. Today this is truer than ever before. Air war has blown the roof off ideas, money and experimentation for the Army Air Forces.

Basically, our fighting planes for two decades had been designed on World War I experience, commercial aviation and theory. We spanned oceans and put long range into our bombers and transports. We pushed our ceiling into the stratosphere at speeds that gave us 400 m.p.h. fighters. To a limited degree we experimented with heavier caliber machine guns and cannon mounted on planes. We developed a precision bombsight.

But war is the only teacher. When our observers reported on the battles of Holland, France and Belgium, we learned that some of our ideas needed streamlining.

First, we had to step up the number of guns on our bombers and fighters. We also had to increase their caliber to pierce the armor-plate being used by the Germans. This meant changing from .30 caliber machine guns to .50 caliber guns that packed greater wallop. More ammunition was needed to stretch fire power.

Equally vital were power-operated turrets. Although the AAF had anticipated war in Europe, our engineers had not progressed as far as the British in turret design. It was impossible to adapt British turrets to American planes, since they were designed for .30 caliber guns. Our trend was toward heavier calibers. Completely new turrets had to be designed for our aircraft.

Today our Boeing *Flying Fortresses* are considered some of the most formidable airplanes in the skies anywhere. This has led to some odd reversals of function.

There is on record a case where two *Fortresses* escorted back to their base 15 fighter planes. And in some theaters, fighters have been equipped with bombs and sent over to do the actual attacking, while *Fortresses* were sent along to protect the mission.

Armor plate on aircraft was long debated.

"Too much weight, and inadvisable," some AAF engineers reasoned.

Actual combat changed their views. Our planes went into battle without armor protection and some of those that came back were too badly shot up to fly again.

In production for AAF is Lockheed's fast, high-altitude transport "Constellation," above, equipped with pressurized cabin.

First experimentation with pressurized cabins occurred in 1937 with the Lockheed XC-35, left, based on the "Electra."

Reported Maj. Gen. George C. Kenney, one of the observers who saw the Battle of Britain in 1940: "The pilots themselves demanded more protection. They didn't like the idea of going into battle without some protection around the cockpit and other vital parts of the airplanes. This was true of both sides."

As a result, armor plating was put on most of our fighting planes. At first it was quarter-inch armor. Then, as heavier caliber guns came into use, this was increased to heavier armor around cockpits, turrets and certain power plant areas.

Another problem concerned leak-proof fuel tanks. Combat proved their dire need. Installing leak-proof tanks meant tearing an airplane apart, putting rubber bags inside the tanks, thus adding one pound of weight for every gallon of gasoline. Therefore, the trend has been to carry a minimum amount of fuel in leak-proof tanks. Extra fuel is carried in droppable tanks inside bomb bays, or under the wings or fuselages of fighters.

Droppable tanks have so increased the range of fighters that they can be flown to combat zones. Fuel slung under the belly or wings of the fighter is used before the enemy is sighted. This dead weight dropped, the pilot switches to leak-proofed fuel tanks that carry him through combat.

Long before the war, Wright Field put increased emphasis on high altitude operations. The plane which can fly higher—and stay there—has the edge over the enemy.

More accurate antiaircraft fire also has forced planes upward.

During World War I, pilots of both sides would fly over ground antiaircraft batteries and stunt while the big guns wasted their shells. This war is different. Guns on the ground are so accurate that they make it extremely dangerous for any plane under 10,000 feet.

Yet the problem chiefly concerns personnel and not airplanes. It is possible to get the machine up to very high altitudes, but above 10,000 feet a person needs oxygen. This particularly applies to the bombardment airplane, where crew members are required to fly at high altitudes for several hours at a time. Consequently, the oxygen equipment for such a battle plane is rather extensive. But when that problem is licked, as it is today—since our bombers carry plenty of oxygen—there still is the matter of crew fatigue. Living in high-altitude air for any period of time is tiring to personnel and lowers their efficiency. It is natural that we have turned to the development of pressurized cabin airplanes.

The Air Corps in 1937 brought out the first pressurized cabin airplane in the world, the Lockheed XC-35. Since that time there have come into existence the famous TWA Boeing *Stratoliner*. More recently there is the Lockheed *Constellation*, four-engined transport that the Army has taken over as a cargo carrier. It has a new kind of pressurized cabin.

Low-pressure chambers, simulating high altitudes, permit experimentation with new equipment without endangering lives.

There is, of course, the question of vulnerability of the pressurized cabin, which many have long feared, for one bullet would destroy its effectiveness. This is an issue that is hard to dodge. The pressurized cabin, as we know it today, is more vulnerable than the unpressurized cabin. Steps are being taken to improve it so that this problem will be licked. Yet, on the ground, in specially built high altitude pressure chambers, experts at Wright Field have proved that holes can be patched up unless they are too large and that personnel can stand sudden increases in pressure.

War is demanding increased electrical power in our fighting planes. Once our gunners were satisfied with a ring sight or a bead sight. They just swung their guns into action, squinted and let go with a volley of shells. Now they are demanding an electric sight.

The terrific speeds of the modern airplane do not permit them to swing their guns into firing position against 300 m.p.h. (or more) slipstreams. Small electric motors have had to be developed for electrically-operated gun turrets. The need for these and other electrical devices have made the big bomber a

Large-capacity raft (above) designed to anticipate needs of survivors, includes radio transmitter, fishing kit, flares, sail.

generator plant capable of furnishing the lighting needs for a village of 300 people!

Wheels and brakes represent another major problem. More weight in warplanes has increased landing speeds of some craft to more than 125 m.p.h. Better, surer brakes were imperative.

Says one engineer: "During a maximum deceleration stop, the brakes on one type bomber absorb about the same horsepower that the plane's engines deliver during the take-off."

The tricycle landing gear has made the brake job even more difficult. Reason is that pilots tend to use the brakes immediately when the wheels hit the ground. With conventional landing gear this was impossible because the airplane would nose over and plow. Tricycle gear allow instant braking—and excessive wear. Many planes require brake relining several times a month.

Our African campaign added all the problems of desert operations. Sharp dust ruins the innards of an aircraft engine. Power plants that will normally run for 250 to 350 hours without overhaul are "shot to pieces" in 50 hours or less under desert conditions. The only remedy was to devise new filters that keep dust from the vital parts of engines. These filters are now standard for desert aircraft.

The other extreme is winter operation. Our forces battle some of the world's coldest climates in Alaska, Greenland and Iceland. As a result our planes have to be winterized. Winterization means changes in addition to de-icers for the propeller, the pilot's windshield, tail surfaces and wings. Heat must be supplied from the airplane for the guns, bombsight and other equipment.

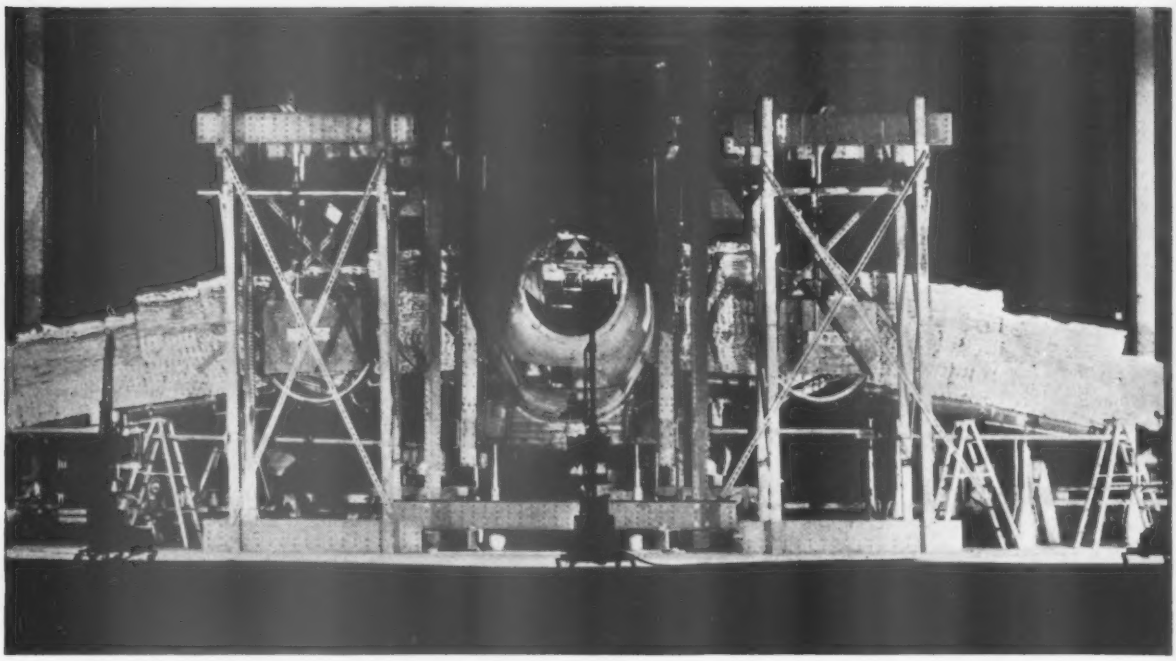
The Engineering Division of Materiel Command, Wright Field, is responsible for the solutions to many war-created problems. It develops prototypes to the point where they are ready for quantity production, then corrects poor performance that shows up in service.

To insure availability in case of forced water landing, automatic pop-out rafts are installed in top of fuselage.

Of the three main divisions at Wright Field, Engineering Division is the oldest, having been organized in 1917 as a technical section of the old Signal Corps and placed at McCook Field. It works with the National Advisory Committee for Aeronautics (NACA), with educational institutions and with other interested organizations and individuals. The Division has 10 laboratories—aircraft, armament, equipment, materials, photographic, power plant, propeller, engineering shops, Aero Medical Research and technical data.

Engineering Division has an Administrative Staff and a Technical Staff. A Foreign Developments Branch evaluates all foreign aircraft developments including those of our enemies. When a new type of plane is contemplated, the Technical Staff prepares in specification form the general characteristics desired. The Germans may have sent a new fighter plane into the Mediterranean skies. Perhaps the Japs have introduced a new bomber in the Pacific. Engineering Division must outline the AAF answer sought—speed, range, armament, armor, structural strength, stability, maneuverability, materials, ease of production and ease of maintenance. These are figured out on paper before the actual airplane is started.

(*Continued on page* 325)



One job at Wright Field is to prove designs for the Army Air Forces. This wing of Martin "Marauder" bomber is carrying 25 per cent more than maximum designed loading. In fact, more than 60 tons were stacked on it during test pictured above.

NERVE CENTER OF

Field laboratory and great scientific institution, Wright Field develops and tests the aircraft, auxiliary equipment and accessories used by the AAF.

ONE day in the summer of 1923, a small group of men stood in front of a decrepit tin-roofed hangar at old Wilbur Wright Field, Army Air Training Center. A few miles away was Dayton, O., where the Wright brothers in their small bicycle shop built the first airplane.

Tall, outspoken Brig. Gen. William "Billy" Mitchell stood with his hands on his hips, studying the place. With him was Maj. Gen. Mason M. Patrick, then chief of the U. S. Air Service. They had flown from Washington, D. C., that day to inspect the airport. Their report to the War Department would make up many a military mind.

"It's too damn small," Mitchell snapped.

His superior, General Patrick, agreed.

"That's right, Bill," he said. "What we need is all that land across the valley—a gigantic experimental field where we can run special tests, speed trials, do a little bomb practicing and some extensive test flying."

What Generals Patrick and Mitchell foresaw is a living, growing project spread out over nearly 6,000 acres of rich Miami River Valley farmland. It is the world's largest aeronautical research laboratory, in whose shops and buildings men have created the modern fighting plane. Appropriately it is called Wright Field, in honor of the men who were first to fly in a heavier-than-air flying machine.

This is the "nerve center" of all American air power.

Night and day the roar of mighty engines on test stands can be heard in downtown Dayton. Huge bombers and sleek pursuit planes take off and land (one every three minutes) on long concrete runways that reach out ribbon-like from the "hub." Overhead is the "swooshing" of large gliders, great gull-like, motorless craft which move on the wind.

The skies above Wright Field are seldom clear of planes, for this is the test center where they put water in gasoline to see what happens at 30,000 feet, where stormy weather is a challenge to fly.

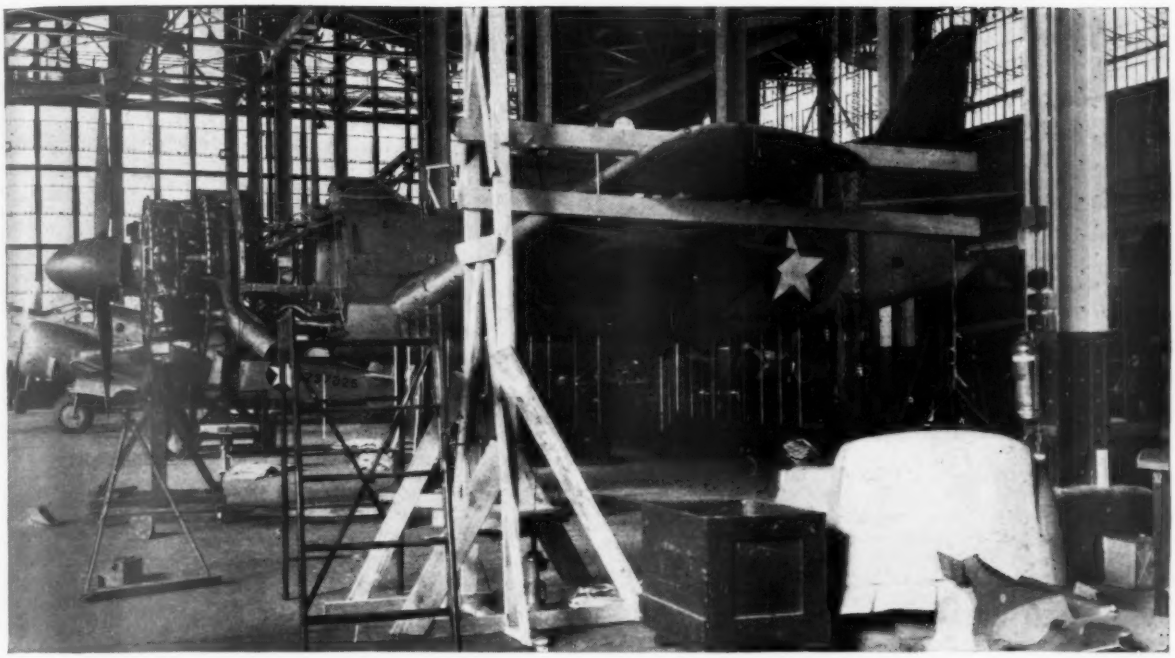
In this "gadget lab," civilian and military minds create, develop and test without mercy every new Air Forces device from buttons to bombers.

At night, far from battle's skies, it is the city of light—the green, white, red and blue mystery of air science at work. In vast low buildings engineers greet dawn over drafting tables where 400 m.p.h. fighters and global bombers are born. Seven nights a week some plane is roaring above Ohio's darkness. Its test mission may answer a baffling riddle on some fighting front. Test pilots themselves get only cat-naps in a little hotel all their own (The DeGink), right on the flying line.

Looming big in the night, the silver wind tunnel uses enough electrical current in its 40,000-h.p. motor to light a city the size of Columbus, Ohio. Inside this rectangular tunnel, 20 feet in diameter, air is sucked at 400 m.p.h. and full-sized airplane sections undergo aerodynamic testing.

To new arrivals, this airfield looks like a concentration camp with its hundreds of guards and its "fortress" fence. Actually it is a great scientific institution. It is so large that a special bus line running from one corner to another must make a half-hour trip. New buildings rise between dawn and dark and contractors ask: "What building do you want here tomorrow?"

More than 30,000 people work here. They are young and old, Army generals and buck privates, civilians—men and women, colored and white. They come from farms, classrooms, business offices, from Main Street and Wall Street. There are engineers, professors, doctors, lawyers, bricklayers, plumbers, writers, scrub-women, policemen, waitresses, secretaries. They



With heavy hydraulic jacks supplying force on wings and fuselage to check stressed points, Army version of Navy's Curtiss "Helldiver" undergoes static tests. Wright Field technicians rigorously test equipment for use of Army Air Forces.

AIR POWER . . .

Static tests on Curtiss "Commando" troop-cargo transport. The fuselage interior is piled high with shot bags to determine maximum weight that can be carried before failure. Activities such as this have tripled Wright Field's activities since war began.

rise early and ride miles in trailer busses which were built for war, not comfort.

In October, 1917, with the first AEF headed toward Europe, the War Department established a large aeronautical engineering division and flying field at Dayton, O. It was named McCook Field—in honor of Gen. Anson McCook on whose farm the field was constructed. General McCook had helped develop the observation balloon during the Civil War.

McCook Field, in two years, had grown to 69 buildings which included many hangars, a hospital, shops, laboratories, offices, a wind-tunnel and a force of nearly 2,000 officers and civilians. But McCook had its limits. A big sign hung over one of the hangars—THIS FIELD IS SMALL, USE IT ALL.

This planted the seed which grew into a Congressional debate, struggled through politics and emerged several years later as an appropriation of several million dollars to build a larger test center. The new field, a tract of 4,500 acres donated to the Government by the citizens of Dayton who wanted to keep the heart of aviation near the home of the Wright brothers, was opened on Columbus Day, 1927.

Officially it was called Wright Field, Materiel Division U. S. Army Air Corps.

Taken from the French, the word "materiel" signifies every object, raw material and part, from a complete flying field to the smallest bolt or piece of metal skin—from a complete bomber to a pair of flying goggles—connected in any way with the operation of Army aircraft.

Wright Field's job, then, was to develop advanced aircraft, auxiliary equipment and accessories for use by the Army Air Corps; to procure this equipment and accessories for issue to the various Air Corps units and to test the real worth of all experimental types of equipment. In carrying out that task at old McCook Field and during the early years of Wright Field, the men in the various laboratories took on the big job of taming the sky.

They didn't build airplanes here and they didn't teach men how to fly them, for this was no training center. But here was produced the first high-powered, air-cooled radial aircraft engine; the turbosuperchargers.

Here the sextant and the earth inductor compass which made possible the era of the transoceanic flights were first applied to aircraft. A completely new system of night flying over lighted airways was introduced. Night and color photography were perfected by experts in the photographic laboratories. Technicians in the equipment laboratory designed and developed the first seat-type parachute which is saving lives every day all over the world.

Wright Field's men flew higher:

One day in 1920, they bundled Maj. "Shorty" Schroeder up in a teddy bear suit, stuffed him into the cockpit of a LePere biplane powered by a Packard engine and sent him up into the unknown. At 38,180 feet, when the little ship trembled and shook and wouldn't climb another inch, Schroeder's eyeballs froze, his hands numbed on the stick and his senses blanked out as the plane spun dizzily earthward for six miles before he managed to pull it out and land safely.

A year later, Lieut. John A. Macready went even higher, clad in a cumbersome leather flying suit which had in its lining small electric wires designed to keep him warm. He had taped to his face a new oxygen mask. He wore electrically-heated gloves which helped him to hang onto the controls up where the ship bounced about crazily in the thin air. Untried, heavy-soled sheepskin-lined boots covered his feet. Gelatin was smeared on his goggles so frost wouldn't cloud them.

He pushed the plane up to 40,800 feet and for five minutes it "swung and rolled in suspension" but Macready held it there pitching and swaying in the icy air while he jotted down notes so men on the ground would know what was wrong and could do something about it.

They flew farther:

The same John Macready and his fellow officer, Oakley Kelly, an unforgettable flying team, climbed into the cockpit of a big, crude, heavy Fokker single-engined monoplane—one of the Army's first transports—and flew non-stop from San Diego, Calif., to Indianapolis, Ind. Later, Macready and Kelly took off from McCook Field for New York and flew non-stop from the big eastern metropolis to San Diego, Calif., the first transcontinental non-stop flight in history. Two other Wright Field airmen, Lieutenants Maitland and Hegenberger, in 1927, flew from Oakland, Calif., to Honolulu, Hawaii, the first to span this much of the Pacific.

They flew faster:

Lieut. Alexander Pearson in a Verville Sperry racer set a world speed record for 500 kilometers over a triangular course on March 31, 1923, at McCook Field. On that same day another McCook Field test pilot, Lieut. Harold R. Harris, in a DH-4L biplane smashed to a new world's record for 1,000 kilometers over a triangular course—nearly 200 m.p.h. And Lieut. Russell Maugham who sped dawn-to-dusk across the continent in a special-built Army racer.

Whirl test stand for propellers. A six-bladed prop after undergoing a simulated "winter" test. Water spray formed ice.

Shot bags test fuselage of new fighter at Wright Field. These static tests indicate whether plane can stand excessive stresses.

They flew blind.

Major General Doolittle, then a lieutenant, in 1929 climbed into an ordinary biplane and pulled over his head a large canvas covering which cut off all outside vision. Doolittle piloted the plane by his instruments alone. His take-off was perfect, the landing a little rough, but he had proved that "blind flying" was practical.

That was the beginning. Thanks to instruments devised by Materiel Division, blind flying is now as common as the modern transport airliner.

Behind the scenes in the laboratories, men on the ground did equally great things of which few are aware. They developed the first successful parachute. They made metal propellers standard on almost every military and commercial plane. They added controllable-pitch and full-feathering blades. They substituted Prestone and other fluids for water in the liquid-cooled power plants, reducing radiator sizes 60 per cent and returning the liquid-cooled engine to its place in air power.

This is Wright Field. New and greater advancements in flying pour forth daily from these experimental laboratories. War has made Wright Field three times as large, its task thrice as demanding. Yet basically the job is the same: get the best planes, get them quickest, prove them to be unexcelled anywhere and get them into the blue where they can help us win.

The old Materiel Division and today's Materiel Command are the same. Wartime has merely enlarged the organization. In the beginning, the old Materiel Division was charged with conceiving the airplane. Men here were responsible for creating on paper the new designs which would fit into our peacetime military aviation. They sketched their creations "on the backs of envelopes"; had expert designers work out every detail, put it down in blueprint form and then went to the various manufacturers and get them to build it.

These engineers also were charged with experimental development—static testing to learn aircraft strength, test flying to learn its performance "upstairs." A good plane was put into peacetime "mass production"—300 airplanes of a single type. Then Materiel Division issued the new model to tactical units in the United States, the Philippines, Panama and Alaska. Even in service the plane remained the responsibility of Materiel Division. Wright Field was charged with keeping it serviced, repaired, always flyable. Air units were supplied with reserve materials—spare parts and spare airplanes. The Materiel Division, from 1927 to 1942, handled the airplane from its introduction to service until it was declared obsolete.

Shortly before Pearl Harbor our air generals in Washington foresaw that expansion was outstripping the Materiel Division. The result was Air Service Command, a new organization closely associated with the Materiel Division but still a separate unit. To make jurisdiction equal, Materiel Division became the Materiel Command with a major general at its head. Now Wright Field's task was to *conceive* the airplane design and put it through its *experimental development*, order it in quantities and get it into production quickly.

Air Service Command would issue the planes to squadrons and care for them in the field. Materiel Command saw a newborn airplane through its short-pants stage and the Air Service Command took over the grown-up warcraft. Yet Materiel Command never lost interest in its child, often gave expert advice to save a plane's life in the field.

Now this has changed further.

The activities of Materiel Command, Air Service Command and Air Transport Command were so closely linked and in so many cases overlapping that it was deemed advisable to place them all under direction of an assistant Chief of the Air Staff for materiel maintenance and distribution. Maj. Gen. Oliver P. Echols was appointed for this important post. This directorate has the same job relative to the Air Forces as Army Service Forces has to the ground forces. It is located in Washington where its division chiefs can co-ordinate closely with the Commanding General of the Army Air Forces.

Yet the plant or factory is still Materiel Command. Its separate operating units are Engineering Division, Procurement Division and Production Division. These are divided into sections, the sections split up into branches or laboratories and further sub-divided into units.

The section is a self-contained operating group with its own manager; its own offices, foremen and workers. It has its own shops where the work is carried out.

Duties of Materiel Command and its respective divisions and sections are administrative and technical. The first handles necessary paper work. The second runs the machinery and turns out the product—the best possible warplane and everything to go with it.

Nearly 25,000 civilian workers make Wright Field unlike any other Army Field. It must have two bosses, a military supervisor and a civilian supervisor. To fit this jig-saw picture into

(*Continued on page* 304)

BUYING OUR

Lockheed "Lightnings," with "Ventura" in the background, are two of many plane types ordered in quantity by AAF Procurement.

"HERE'S $30,000,000,000 dollars! Buy us some combat planes. "Get a lot of heavy bombers like the *Liberators* and the *Flying Forts;* some of the medium types like the *Marauder,* the *Boston* and the *Mitchells* which Major General Doolittle used over Tokyo.

"And don't forget fighters. Buy thousands of them—*Airacobras, Lightnings, Tomahawks, Mustangs* and *Thunderbolts.* We need them to keep the bombers going over and coming back.

"Buy plenty of good training planes, too, so our men can learn to fly the best. Then, after you've done all this, buy the engines and the propellers. Buy oil and gasoline and enough spare parts to keep 'em flying."

This was the nation's order last year to Wright Field—the purchasing agent of the Army Air Forces, the biggest shopper in the world.

The Procurement Division of Wright Field does most of the shopping and buying for the whole AAF. In the two years prior to June 30, 1943, obligated funds approximated $30,000,000,000 for aircraft, aircraft equipment and maintenance supplies. For the next year large amounts will continue to be obligated because our bombers are going to be bigger, our fighters are going to fly higher and farther until they spread out all over the world.

Says one high-ranking officer of the Procurement Division: "Wright Field deals every day with millions of dollars, yet keeps a close lookout for saving pennies." The experts try to do their buying with the care of a thrifty housewife.

To understand how this big job of procurement is accomplished it is necessary to know that Under Secretary of War Robert A. Patterson is responsible for all Army contracting procedure including the Air Forces. He is the final authority in respect to all War Department purchasing whether it be a big bomber or the tiny bolt which helps hinge the plane's rudder. He must sign or delegate authority to sign all contracts for the AAF that exceed $5,000,000.

The commanding general of the Materiel Command can approve contracts which total not more than $5,000,000. The Procurement Division is responsible for these Air Force contracts up to $5,000,000. But whether it involves $1,000,000,000 or $100, virtually every contract pertaining to AAF procurement is written, carried out and paid for through the Procurement Division.

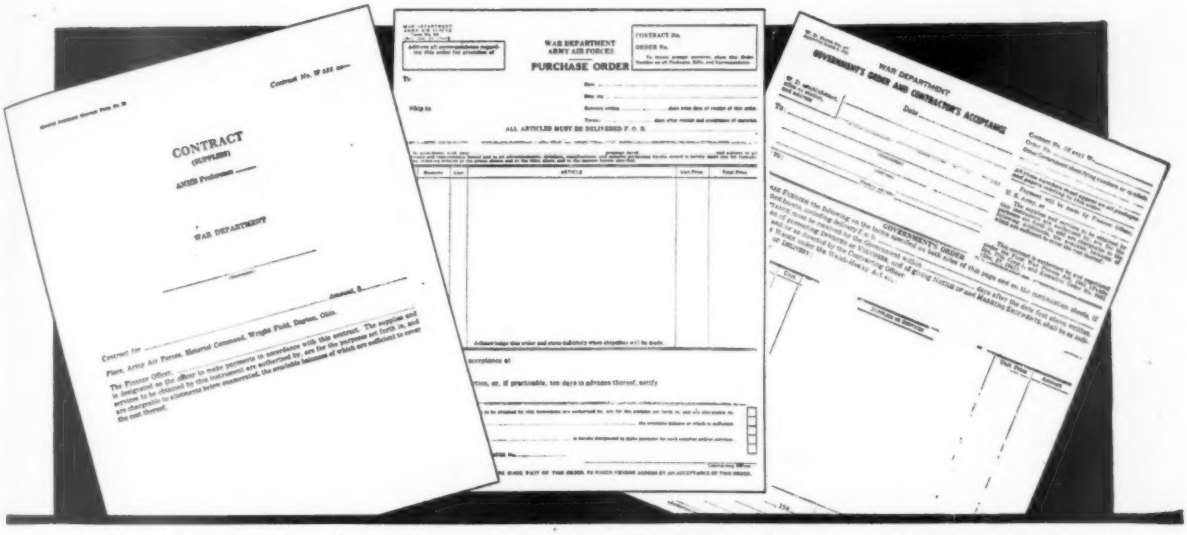
"Mars has a ravenous appetite," said the ancients. But Mars was never hungrier than in modern war. To build one four-engined bomber takes enough aluminum for 55,000 coffee percolators; enough alloy steel to make 6,800 electric irons; the steel in 160 washing machines; enough rubber to recap 800 automobile tires, and enough copper for 550 radio receivers. Wright Field's Procurement Division must buy every piece of equipment which goes into that plane. Spare parts, engines, propellers, de-icers, oils, gasoline—all must be purchased separately by contract. And war demands thousands of bombers every month. To get them, the Procurement Division must nudge, prod, bargain and sign on the dotted line.

Records of the division list approximately 25,000 companies from which purchases can be made. Not all are utilized. Instead, part of the task facing the division's experts is to pick concerns best suited to do specific jobs and see to it they are awarded contracts. Particular attention is given the "little fellow" in order that thousands of small U.S. manufacturers can continue in efficient production.

The Procurement Division might be compared to a large brokerage house. In its many offices millions of dollars of contracts for America's growing air power are signed and approved daily. Big aircraft manufacturers get bigger contracts than ever before and small manufacturers become big contractors overnight. The job is done quickly, accurately, ef-

WARPLANES...

In the two years ended June 30, the Procurement Division of Wright Field spent $30,000,000,000 for aircraft, equipment and supplies, ranging from the biggest bombers to mukluks.



The AAF uses three types of purchasing contracts: formal contracts (left), purchase orders and short-term contracts.

ficiently. A delay in buying might mean a delay in action overseas—defeat in a vital battle, the waste of lives and equipment.

Even by our enemies, American industry is conceded to be the world's greatest. Yet, without proper authority to go ahead on a contract, materiel cannot be purchased to start building a single plane. It takes "paper work" to start the contract order into actual production. Democracy wants strict account of what is being done with the billions it spends for war bonds.

The Authority for Purchase (AFP), a term frequently heard at Wright Field, starts the ball rolling for AAF procurement. The Engineering Division, Production Division or any field unit initiates the AFP and sends it to Procurement for action. The AFP describes articles in detail, tells how many are wanted, how much they'll cost. It will also show that necessary funds are available and authorized.

Practically all purchases now are made by negotiation under the Act of December 18, 1941, often called the "First War Powers Act." Contracts may be drawn by any method which will speed efficiency and still protect the Government. Several contractors, peacetime competitors, may negotiate as a "pool" to make the same article.

In negotiating all contracts, particular regard is paid to the following considerations:

1. Securing delivery in the time required by war's needs.
2. Conserving the facilities of concerns whose engineering, managerial and physical resources can best handle more difficult war production problems.
3. Placing contracts with firms able to meet the contract with the least added "critical" materials—machinery, machine tools, factory space.

These three "by-laws" may dictate purchase from a concern not quoting the lowest price. This is hard for the layman to understand. But it is essential to the war effort where time is all-important.

Under peacetime buying most procurement was made by circular proposals wherein requirements for quotations were set forth in an inquiry to interested manufacturers. War has largely eliminated this advertising method in speeding the buying program.

A sign in one office reads:

"Time can be shortened, but cannot be eliminated."

Speed-up of contracts and legal action required for their issuance is vital. It may mean the difference between life and death for fighting airmen somewhere. It is today's byword for the Procurement Division.

After the manufacturer has been selected, legal experts draw up the contract agreements. The laws governing Federal contracts leave no room for doubt or error. Adjustments cannot be made with the same ease that characterized private business contracts. A vigilant eye must oversee the hundreds of AFP's that flow through the Procurement Division each week.

The Division is split into five sections: Administrative, Purchase, District Procurement, Contract and Procurement Control.

The Administrative Section acquires the necessary personnel and handles organizational paper work.

The Purchase Section handles the two kinds of buying—general procurement and aircraft procurement. General procurement includes everything not pertaining to aircraft, engines and propellers. It makes the vast majority of deals and is second only to aircraft procurement in dollars and cents. Aircraft Procurement often has individual orders in excess of $1,000,000,000.

The District Procurement Section, although its headquarters are at Wright Field, works with offices spread out all over the U. S. in six AAF districts—Northeastern, Southeastern,

AAF MATERIEL COMMAND

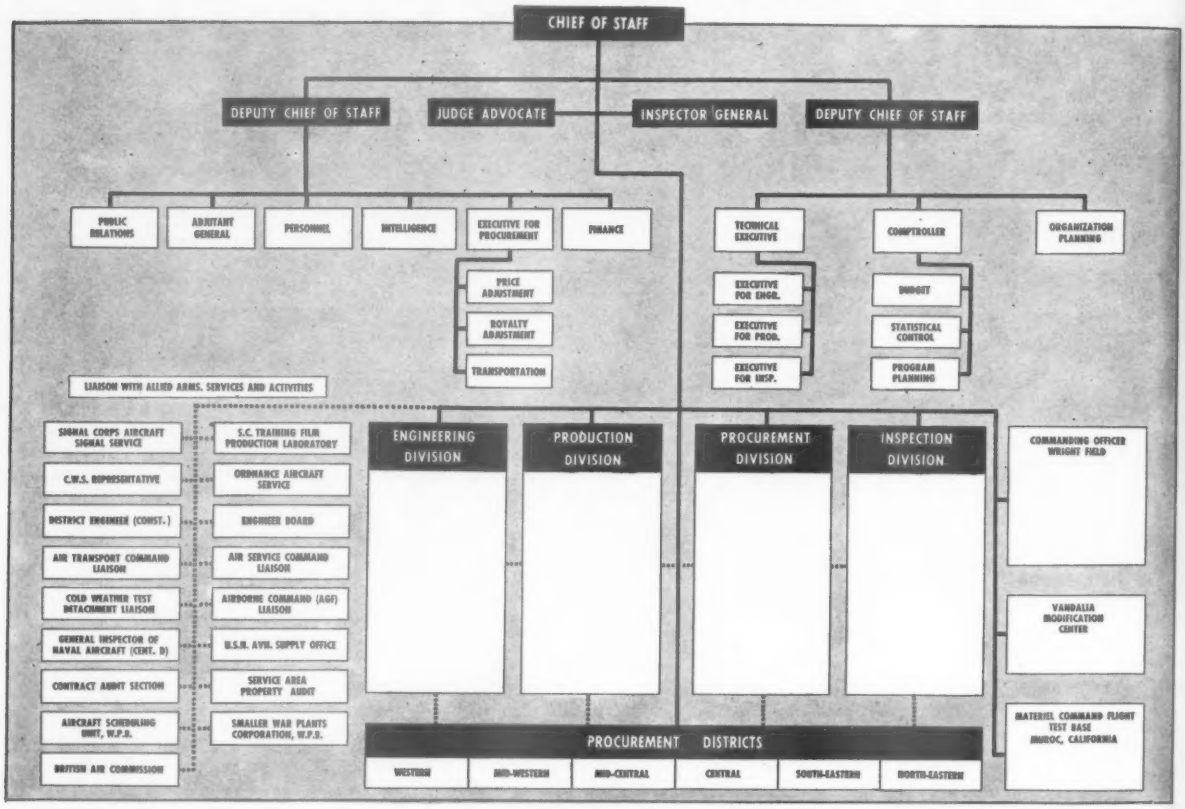


Diagram illustrates place of Procurement Division in Materiel Command. Procurement handles nearly all purchasing procedure.

For decentralized efficiency, the Materiel Command is divided into six procurement districts with headquarters at Wright Field.

The status of any given contract can be determined in a few seconds in Wright Field's Authority for Purchase Department.

Midwestern, Central, Midcentral, and Western. District headquarters are in New York City, Atlanta, Wichita, Detroit, Chicago and Los Angeles.

Originally these districts were under the surpervision of civilian inspectors. Now Army Air Forces officers are stationed at the various manufacturing plants scattered through the decentralized districts. The system utilizes new sources and helps put to work smaller manufacturing plants, thus increasing the flow of much-needed materials and distributing the business through prime and subcontracts.

The Contract Section, largest and busiest in the Procurement Division, is its legal agent. It also is the only procurement unit which can accept an AFP. It keeps an accurate record of all requisitions, reporting periodically upon their status.

The Procurement Control Section is the follow-up and records branch. It must see that contracts are fulfilled on time.

These sections embrace various branches: The fiscal branch holds the purse strings, determines which concerns will get advance payments, checks the financial security of each Government contractor. The cost-analysis branch determines the fairness in contracts relative to profits. The preference-rating branch writes all permits for priorities. The follow-up branch must see that the product is delivered at the right place at the right time.

Items of procurement vary. Billions of nuts and bolts, gasoline and oil, steel and aluminum, an electrically-heated flying suit, or a canvas mukluk boot which our flyers are using in the Aleutians—these are just samples. In order to get the best it is essential to employ officers and civilian personnel who are intimately acquainted with the many items so they can talk smart shop with manufacturers.

A man who knew nothing about high-octane gasoline would be a fool to discuss a $10,000,000 contract with the representative of a big refinery. This the Procurement Division guards against. It has specialists who do only the jobs of negotiation. In drafting a contract they work closely with legal experts to make sure that Uncle Sam gets only the best materials in existence.

Procurement regulations rarely allow an AFP to request procurement from a particular manufacturer. This is a protective measure. That manufacturer may not be able to turn out the product. He may not have sufficient facilities to make it. He may not have the materials. The Procurement Division, therefore, operates on a system all its own: "Buy an item or its equal." This means contract with any manufacturer so long as the item meets requirements and serves its purpose.

Each of us faces the same problem daily: Someone sends you to the drug store to buy toothpowder. "Get me Jones' toothpowder," they say. "Don't get me any other kind." Yet the druggist may not have Jones' toothpowder. You *could* buy an "equal" brand, one suitable for its purpose of cleaning teeth. AAF Procurement works the same way.

Three types of purchasing contracts are in use by the AAF today: (1) purchase orders; (2) short-form contracts; (3) the formal contract. Around these three legal forms revolves every Wright Field purchase.

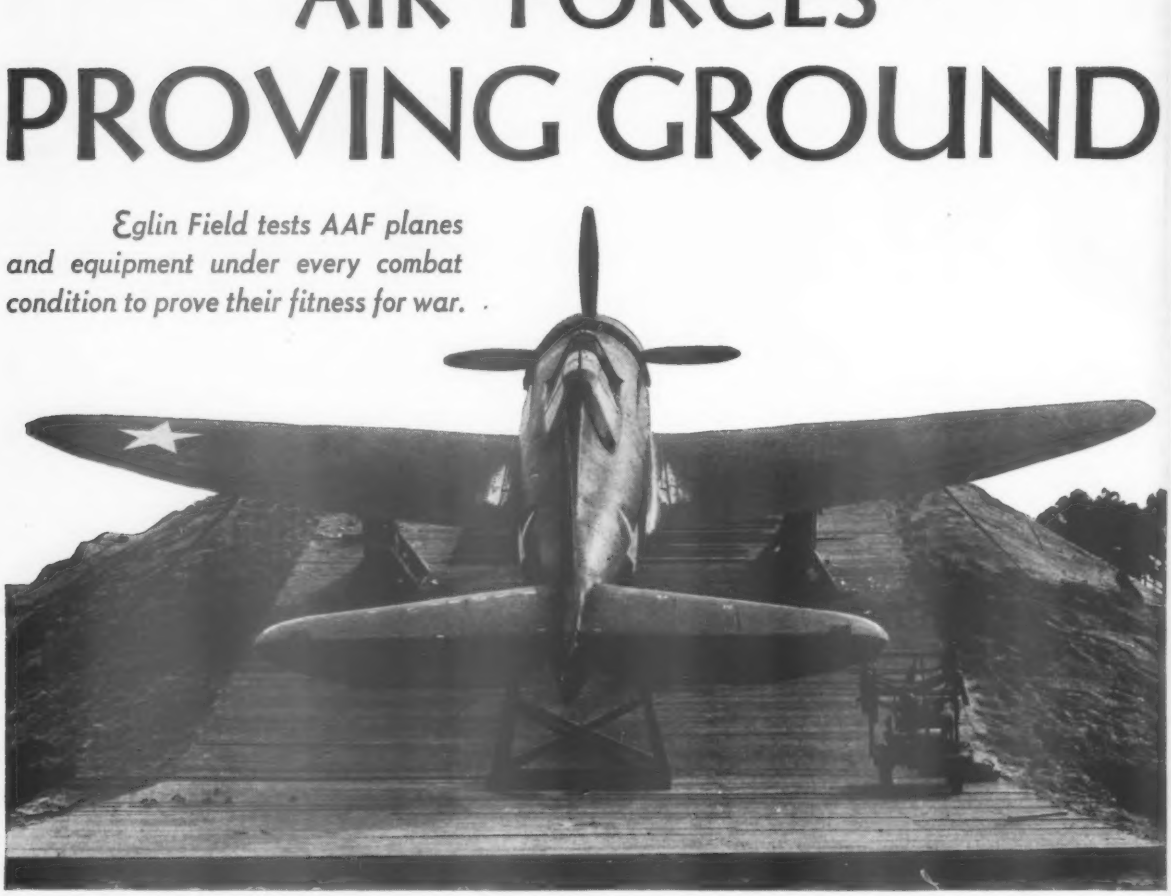
Simplest is the purchase order. It can be a single sheet of

(*Continued on page* 357)

Douglas "Skymaster" takes shape on the production line under supervision of AAF officers representing Procurement.

AIR FORCES PROVING GROUND

Eglin Field tests AAF planes and equipment under every combat condition to prove their fitness for war.



This "Thunderbolt," complete and in flying condition, is wrecked by machine gun and cannon fire in Eglin Field test. Propped up to simulate tail attack by enemy aircraft, effect of shots on cockpit and other vulnerable parts is determined.

ON the ground and in the skies over Eglin Field, set down in the heart of the Choctawhatchee National Forest in northwest Florida, the proving ground of the Army Air Forces is hammering the shape of victory.

The mission of the Proving Ground Command is to test and evaluate the combat-worthiness of aircraft, accessories, equipment and supplies. Here the performance characteristics and the capabilities of the combat tools of the Army Air Forces are subjected to gruelling tests with the single purpose of *proving* themselves for tactical uses, and of demonstrating how they may be employed with maximum effectiveness.

The purpose and the objectives behind the organization of the proving ground are speeding victory for the Army Air Forces in every theater of war. The very existence of the proving ground shows the Army Air Forces' determination to equip its combat units with fighting tools that have been tested and proved worthy, and that represent the finest products of American ingenuity and manufacturing skill.

Need for such an organization as the Proving Ground Command became apparent even before Pearl Harbor as the nation faced a world at war. New designs and developments in combat aircraft burgeoned. Advances in armament, in the number and types of turrets, in fire-control systems and items, in aircraft ordnance, in all manner of accessories and supplies, began to pile up.

Testing for research and experimental purposes was one matter. Facilities were available and growing at the Materiel Center, Wright Field, and in the aircraft plant laboratories. But the real problem was this: did these developments meet real combat conditions with maximum effectiveness? Facilities for such tests were scattered, unorganized, and meager at best.

In the autumn of 1941, the Air Corps Board, an advisory body to the Chief of the Air Corps, moved down from Maxwell Field, Ala., to Eglin Field, Fla. The board made recommendations intended to improve the Air Corps. Its directive required that such recommendations be based upon the results of actual research and tests.

Eglin Field was an Air Corps specialized flying school under the wing of Maxwell Field, with an extensive reservation and gunnery ranges. Because it provided unusual facilities for operational tests and proving, Eglin Field was designated as the Air Corps Proving Ground on May 19, 1941.

The eventual structure of the proving ground soon began to grow apparent. On August 19, 1941, the commanding general of the Army Air Forces, who had fostered an effective proving ground, explained that the equipment and personnel of the Proving Ground Detachment would "be used to test airplanes, equipment and new gadgets and approve their use as tactical weapons."

The proving ground became a reality. In its initial stages the Air Corps Board directed the planning and co-ordinating activities of the Proof Department. The Proving Ground Detachment became the medium for the actual conduct of test operations.

But there were still other transitions to come in order to meet the growing needs of the expanding Air Forces and to fill the requirements for proving and testing the combat capabilities of the flood of new planes, parts, accessories and other

untried equipment coming from laboratory and factory.

On April 1, 1942, the Air Forces Proving Ground Command was activated and made responsible directly to the commanding general of the Army Air Forces. The Proof Department was evolved into approximately its present form. The Proving Ground Detachment became the Proving Ground Group.

Thus was evolved the wartime structure of the Air Forces Proving Ground. The Proof Department plans the test and proving programs, records the results and delivers the reports. The Proving Ground Group actually executes the test projects. Proving Ground Detachments function also at the proving grounds at Aberdeen, Md., Edgewood, Md.; Hope, Ark., and Madison, Ind.

How does the Proving Ground function?

Requests for test projects come primarily from two sources—the commanding general of the Army Air Forces, and the Materiel Center, Wright Field. A letter outlining the project describes the equipment to be tested, outlines the purpose of the test, and itemizes the findings desired. After evaluation, the project is assigned to one of five Proof Department Sections—Bombing, Machine Gun and Cannon, Tactical, Radio, or Miscellaneous Section.

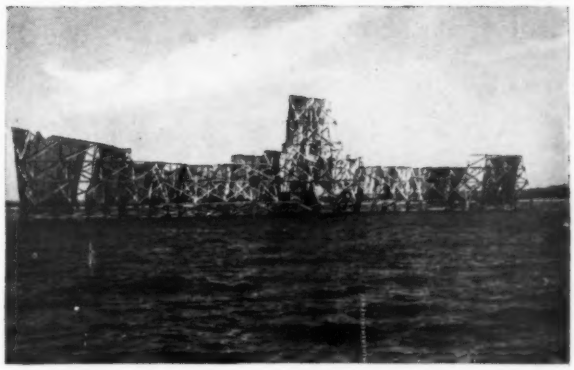
A rough draft of the test program is formulated, examined in conference, amended or modified. Then it is assigned to a project officer who gives the actual testing job to the Proving Ground Group. Here a project officer, a working pilot, fires the guns and flies the plane himself, or personally supervises other experts.

Test installations are provided by the Proof Department Planning and Facilities sections. Progress reports are kept. Results of the completed test are charted by the project officers assigned by both the Proving Ground Group and the Proof Department. If analysis requires the aid of mathematicians, physicists, or statisticians, the Analysis Branch of the Proof Department is called in.

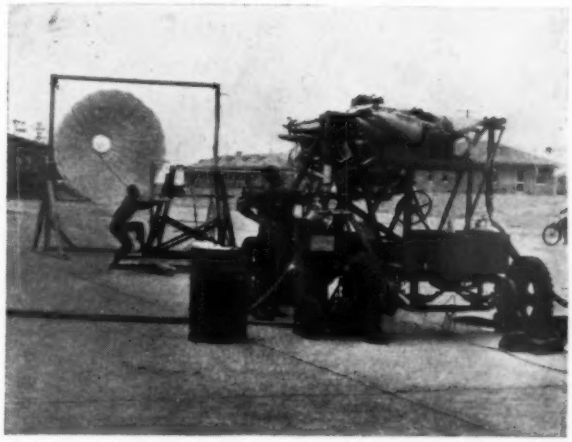
The joint report is submitted to the Proving Ground Committee—the commanding general of the Proving Ground Command, the chief of the Proof Department, the commanding officer of the Proving Ground Group, and the Proving Ground Ordnance Officer. They evaluate further, revise and approve. The completed report then goes to the organization which started the request, plus other interested units.

Wartime activities at the proving ground are the unseen partner of every combat mission the Air Forces fly.

(*Continued on page* 332)



Skip-bombing target is anchored off Eglin Field. Delayed action fuse, making skip-bombing practicable, was developed here.



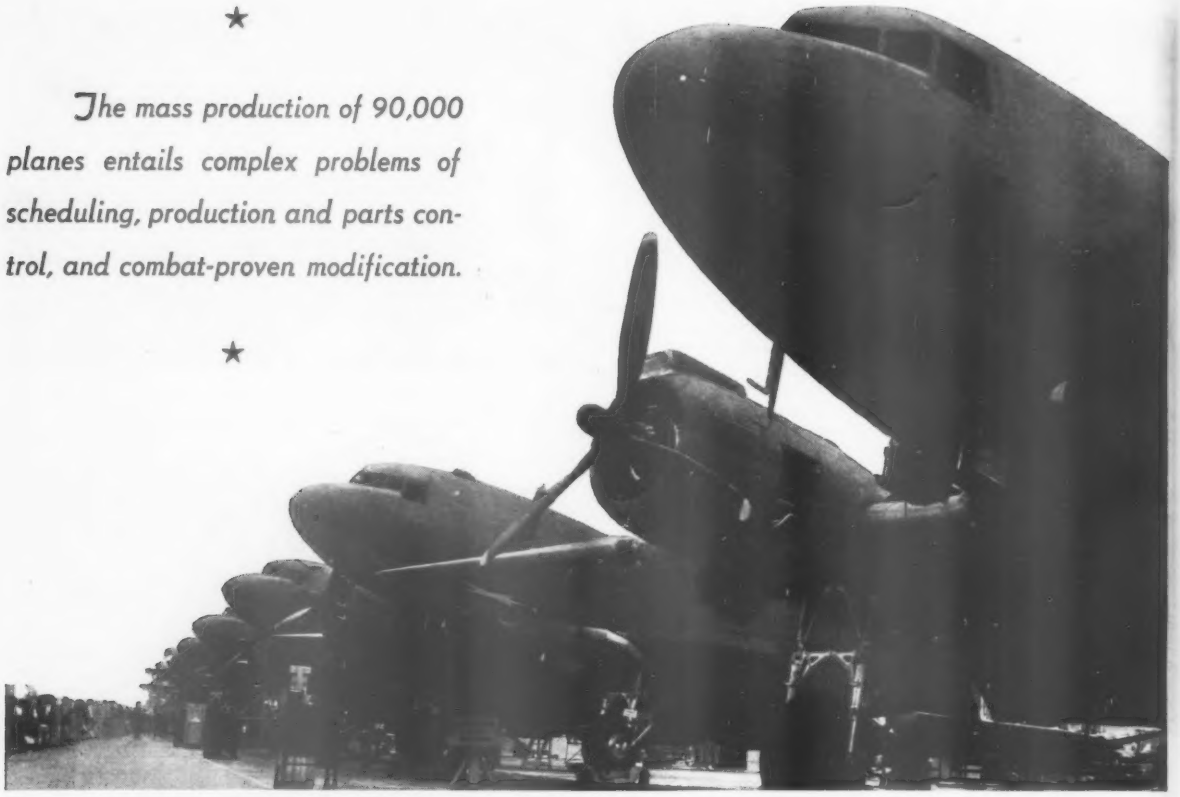
Wind machine sets up a gale on the calmest day to test parachutes and other equipment that must stand up in rough air.

The AAF Proving Ground trains engineers to clear stretches of jungle and scrub and lay steel landing mats for runways. These men will be assigned to units which may have to build landing fields in tundra, desert or forest.

★

The mass production of 90,000 planes entails complex problems of scheduling, production and parts control, and combat-proven modification.

★



Symbol of America's mighty production effort, a group of Douglas "Skytroopers" near the end of their production line.

PLANES BY THE THOUSANDS

THE summer of 1922 found Capt. Edward V. Rickenbacker in Berlin at the Adlon Hotel talking about Germany's future with four of her prominent airmen, Goering, Vandelend, Milch and Udet, two of whom were members of the famous Von Richthofen Flying Circus whose red-nosed Fokkers in 1918 were the terror of France's skies. But now the war was forgotten and the five were expressing themselves on the future of world aviation.

"Eddie," said Herr Goering, "our whole future is in the air. With air power we are going to recapture the German Empire. There are but three things that we need to do—teach gliding as a sport; build up our commercial aviation and create a skeleton for a military air force. Then, when the proper time comes, we will mould all three together and the German Empire will be reborn."

That was in 1922. Thirteen years later Rickenbacker was in Germany again and he met at the same place with the same men. But things had changed. Germany was no longer a defeated nation. She was gaining strength under a new leader —Adolph Hitler. Hermann Goering was second only to the Nazi leader himself in power and Milch was Goering's deputy. Vandelend was head of all Nazi air experimentation and Udet was chief of aircraft production.

Milch brought up the subject of that 1922 meeting.

"Eddie," he said, "remember what we talked about the last time we were together?"

Rickenbacker nodded.

"Well," said Milch, "come along and we will show you."

That day Rickenbacker visited the great Junkers factory and saw 24,000 workers, on a 24-hour basis, turning out big bombers and transports. Those bombers would later destroy Coventry and strike London in the Battle of Britain. From the transports would leap thousands of Nazi paratroopers to capture Crete.

In 1935, Rickenbacker merely saw the key to Germany's rapid air successes which marked the beginning of the second World War. The Nazis were mass-producing airplanes. Production was the keynote to strength for the Luftwaffe and Rickenbacker rushed home to tell us about it.

At first the warning fell on ears that turned away. Then, as the Luftwaffe cast its shadow over all Europe, Americans realized that our aircraft factories, with their 15,000 employees and hand-stitch methods, were lagging. Expansion talk filled the air. Assistant Secretary of War Louis A. Johnson, in 1939, asked for a 5,500-plane program. A few months later this figure was nearly doubled—10,000 planes a year. Then, in 1941,

Plexiglas nose assemblies for Douglas "Havocs" being built for U. S. Army and Navy are readied for delivery.

President Roosevelt asked for 50,000 planes a year. Last year he raised the figure again to 125,000 planes (subsequently reduced to 90,000)—an Air Force which would dwarf the Luftwaffe and the combined air power of the rest of the world.

Producing this number of planes meant the biggest task that has ever faced American industry. It meant building planes as we had built automobiles.

Wright Field's assignment was directing the production, seeing to it that the contracts were signed, that factories got their materials on time, that engines and propellers were available at the right place at the right time, overseeing changes in design, shipping and delivery.

What made it most difficult was time. America was planning to build her gigantic air force, not in 20 years but in 18 months!

To achieve wartime production, Wright Field, in March, 1939, established a Production Engineering Section. Civilians and officers who previously had worked as liaison personnel between the contract section and experimental engineering formed the nucleus of the section.

The new section included 10 branches—Bombardment Aircraft, Pursuit Aircraft, Observation Aircraft and Training and Transport Aircraft; Government Furnished Equipment; Drafting and Records, Specifications and Army and Navy Specifications. Later a Production Survey Branch was added to determine the broad requirements for basic materials such as aluminum, steel and fabrics.

This was in 1940, the year that Detroit and motordom were being converted to aircraft manufacturing. New contracts were awarded auto makers to fabricate parts for assembly by the aircraft manufacturers. It was a memorable year.

America, with her Yankee ingenuity, was at last going to produce airplanes as they had never been produced before.

Meanwhile, Wright Field's Production Engineering Section

(*Continued on page* 312)

Curtiss "Kittyhawk" fighters and giant "Commando" transports being produced on same floor in a huge inland plant.

Fighter pilot equipped for action at high altitudes.

THE FIGHTER

★

"Attack!" is the theme of fighter pilot and plane, a team specifically designed to rid the skies of all enemy aircraft.

★

ONE fighter pilot in China, crossing the southeastern tip of Hong Kong Island, saw an airplane silhouetted against the sunset.

He and six other pilots of the AAF Fighter Group in China had just shot down 19 Jap Zeros in three minutes.

Without thinking whether the silhouette was that of a friendly plane, a shadow or a bird, the pilot moved to attack. An instant before the six .50's would have blazed from his P-40, the other plane wigwagged its wing.

A Texas drawl came through the earphones.

"If that's a P-40 in front of me, wiggle your wing."

The first pilot wiggled in a hurry. These two American planes were the last in the air over Victoria Harbor that day.

With no hesitation, both pilots were attacking.

Attack, attack, attack—that is the absolute rule of AAF fighters, the reason they are clearing the Axis from the skies on all theaters of war.

In speaking of the fighter, the Army Air Forces mean both the fighter pilot and his airplane. What qualities must a fighter pilot have? How does he employ the best characteristics of his airplane against the enemy?

Effectiveness in combat depends not only upon qualities in the airplane, but also to a great extent upon the ability of the individual combat pilot to determine the best characteristics of his own equipment and upon his ability to exploit these characteristics to their fullest extent against the weakest characteristics of the enemy.

A fighter pilot must be alert. He must be aggressive and carry the fight to the enemy. He must be vigilant, must scan the skies for enemy aircraft, be on the alert so as not to be surprised from the rear.

Like a bomber crewman, the fighter pilot of this war must be expert in teamwork. He is employed in formations to destroy the objective. Teammates of the formation furnish mutual support. In addition, the fighter pilot must be an expert gunner.

World War II has proved that young pilots of 20 to 25 years make the best fighters. They have the physical stamina for numerous missions every day at high altitudes and high speeds, performing violent maneuvers. Older pilots are usually more skillful, show better judgment, yet fail to stand the fatiguing effects of continuous fighter operations.

We know that the primary mission of an air force is to deliver a knockout blow to the enemy through the striking power of strategic bombardment. What, then, is the fighter's role in this kind of air war?

The primary mission of the fighter is to assist the bomber to the target with maximum effect, lowest cost. This is done by achieving and maintaining air superiority. To this end, the AAF employs fighters on four types of missions: bomber-escort, fighter-bomber (including strafing), interception and fighter sweep.

Intercept is purely a defensive tactic—to destroy enemy aircraft over our own territory. Intercept missions are dispatched when enemy aircraft are picked up by our aircraft warning system. The fighters are directed from the ground station by ground-air communications so that their flight path will intercept that of the enemy aircraft.

In *bomber-escort*, the objective of the fighter is to use all available means to protect the bomber formation until it is over the target. His tactics are purely defensive. He does not seek combat. He enters combat only when the enemy presses an attack on the bomber formation, breaking off as soon as possible in order to rejoin the escort. This escort protection will not prevent attacks on the bomber formation by enemy fighters but it definitely will reduce our losses. Even when we possess decided air superiority, direct bomber escort increases the striking power of our bombardment missions.

Fighter sweep is an offensive tactic and is employed to eliminate all types of enemy aircraft from the area. They seek combat over enemy territory and, once engaged, push home the attack to a conclusion.

Fighter-bomber is used against targets normally considered wasteful for light bombardment. These usually are mobile installations. Should the fighter-bomber be attacked before reaching its objective, the bombs can be jettisoned and it can assist the escort in combat.

What kind of plane will perform these missions best?

A combat plane is a compromise. No plane has yet been designed which is "best" in all characteristics—speed, power, maneuverability, rate of climb, defensive armor and range. Speed is considered paramount in importance since it allows a pilot to use his initiative to engage the enemy in combat or to terminate it at will.

Yet other characteristics are desirable, too.

Why can't we build a super-plane that will possess *all* these desired characteristics at *all* altitudes? The answer is obvious: An airplane operates in a three-dimensional world. The third dimension of altitude directly affects engine performance. As altitude increases, air density becomes less. At 30,000 feet, for example, there is only one-third the density of air at sea level.

(*Continued on page* 233)

"OPERATIONS" CONTROL ALL FLIGHT ACTIVITIES AT AAF BASES.

CURTISS WARHAWK (ROLLS-ROYCE ENGINE) IS LATEST OF THIS FIGHTER SERIES

THE BELL AIRACOBRA IS A SINGLE-ENGINED AAF FIGHTER VETERAN.

REPUBLIC THUNDERBOLT, WORLD'S LARGEST FIGHTER AND AN AAF MAINSTAY

NORTH AMERICAN MUSTANG IS AAF DIVE BOMBER (A-36) AND FIGHTER (P-51)

POPULAR IN AAF AS WELL AS NAVY IS DOUGLAS DAUNTLESS DIVE BOMBER.

IN-THE-FIELD MAINTENANCE OF A WARHAWK FIGHTER.

142

C91X

46 MORE BLASTS AT THE AXIS . . . *thanks to* PLASTIC

Fifteen pounds saved may not seem like very much to you — but to a turret gunner, it makes possible 46 extra rounds of .50 caliber ammunition which could mean the difference between Victory for him—or the Axis gunner.

In today's combat aircraft, every pound saved can be translated into terms of more fire-power, or extra gas, or added speed. That's why plastic is contributing so much to aircraft efficiency.

In a recent application of this strong light-weight material to power-driven gun turret parts, a saving of 32% in weight was achieved through the use of *Structo-mold, a *laminated-paper* plastic developed by McDonnell.

This type of plastic is particularly adaptable to fabrication in the specialized shapes necessary for turret parts such as gun shield, gunner's seat, canopy door, step, and gunner's floor assemblies; also gun fairing, and apron and skirt assemblies. Equally as strong as those made of metal, plastic parts cost *less* to manufacture.

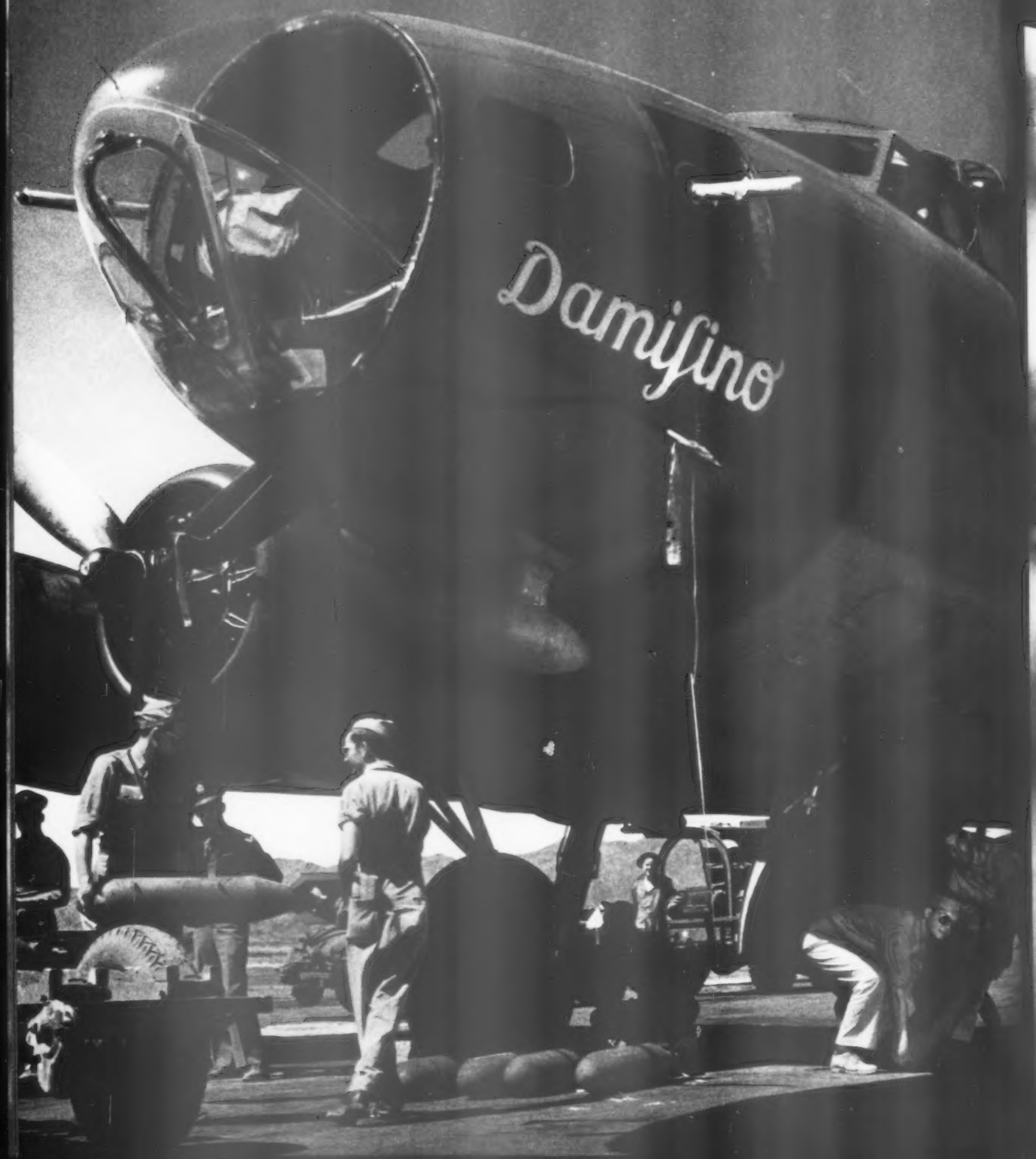
We shall welcome inquiries regarding the production of aircraft parts such as *gun turret assemblies;* also *ammunition boxes,* and *helicopter rotor blades.* Please address all inquiries to our PLASTICS DIVISION.

*Reg. U. S. Pat. Off.

McDONNELL *Aircraft Corporation*

Manufacturers of PLANES · PARTS · PLASTICS ★ SAINT LOUIS-MEMPHIS ★

SAND-FILLED PRACTICE BOMBS ARE LOADED ABOARD A FLYING FORTRESS.



"That brave men shall not die at sea..."

A-P CLOUD

PATENTS APPLIED FOR

MARK 1 (YELLOW)

Hand-held, High-Visibility Smoke Signal. Dispersal 25 Seconds Maximum.

Available Only Through Government Agencies

AERIAL PRODUCTS, Inc.

A-P PISTOL ROCKETS

MERRICK, L. I., NEW YORK

Three fighter pilots compare fight plans before setting out on a mission. Pilot in center holds standard flight computer.

This heavy demolition bomb is one of several to go aboard the Lib in the background. Armorer is attaching a bomb detonator.

NORTH AMERICAN SETS THE PACE
...in the Aleutians

(One of a series describing North American planes in action on the battlefronts of the world)

MITCHELL BOMBERS SINK ALEUTIAN JAPS

KISKA and Attu were a costly speculation for the Japs. They owe much in large measure to North American B-25 Mitchell bombers and other hard-hitting Army and Navy planes.

On this front—as in Africa, China, the South Pacific and over Europe—"North American Sets the Pace"—with damaging blows at enemy ships, planes, land installations. In desert heat or Aleutian fog, the Mitchell has proved its versatility and striking power with each passing day of global air war.

We're proud of this record, but prouder still that we're building better, more deadly Mitchell bombers in greater numbers every day. It's our way of helping to win this war—sooner.

NORTH AMERICAN AVIATION, INC.
INGLEWOOD, CALIFORNIA
DALLAS · KANSAS CITY
Member, Aircraft War Production Council, Inc.

Army-Navy "E" Flag awarded to California and Texas Divisions

NORTH AMERICAN
Sets the Pace!

ARMY E NAVY

H. Haydon Frost

OFF GUADALCANAL
GRUMMAN WILDCATS
SINK JAP DESTROYERS WITH MACHINE GUNS ONLY

FOUR U. S. MARINE PILOTS IN GRUMMAN WILDCATS, RETURNING FROM PATROL TO HENDERSON FIELD AT GUADALCANAL, SPOT A BRACE OF JAP DESTROYERS SNEAKING ALONG THE COAST. ORDERED TO ENGAGE THE SURFACE CRAFT ... WILDCATS ZOOMED UP INTO PROTECTING CLOUDS BEFORE DIVING INTO THE INITIAL ATTACK.

1

CAUGHT UNAWARE, SOON MOST OF THE JAP ANTI-AIRCRAFT BATTERIES WERE SILENCED OR EFFECTIVELY CRIPPLED.

4

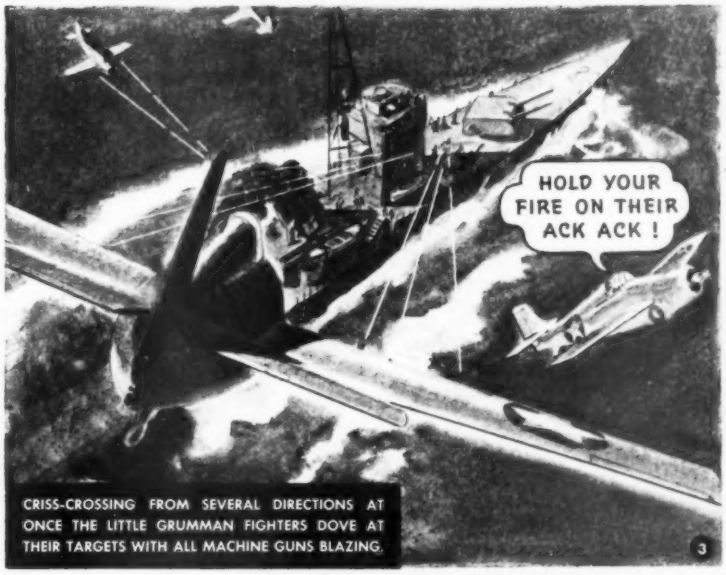
5

WITH THEIR LAST BULLETS SPENT, THE FOUR GRUMMAN WILDCATS LEFT THE DISABLED DESTROYERS FLOUNDERING IN HEAVY SEAS.

8

A FEW HOURS LATER ... OBSERVATION OFFICER RETURNING FROM SEA PATROL REPORTS THE OUTCOME OF THE WILDCAT'S ENCOUNTER.

9


HOLD YOUR FIRE ON THEIR ACK ACK !
CRISS-CROSSING FROM SEVERAL DIRECTIONS AT ONCE THE LITTLE GRUMMAN FIGHTERS DOVE AT THEIR TARGETS WITH ALL MACHINE GUNS BLAZING.
3

CONCENTRATING THEIR FIRE ON THE THIN-SKINNED DECK ARMOR, THE VICIOUS 50 CALIBRE MACHINE GUN BURSTS PENETRATED TO THE ENGINE ROOMS . . . CUTTING STEAM LINES AND STOPPING THE DESTROYERS.
6

TALLY-HO ! HERE WE GO FOR THE KILL... FIRE ON THE WATER LINE
THE WILDCATS, RECKLESSLY PLUNGING IN, RIDDLED THE HEAVILY LISTING JAP SHIPS ALONG THE WATER LINE.
7

SAMUEL JOSEPHS
FANTASTIC AS IT SEEMS . . . THE FOUR MARINE PILOTS IN THEIR LITTLE GRUMMAN WILDCATS VICTORIOUSLY FOUGHT ONE OF THE MOST EXTRAORDINARY AND DRAMATIC ENGAGEMENTS OF THE WAR . . . SINKING TWO JAP DESTROYERS WITH ONLY MACHINE GUNS!
10

GRUMMAN

MAKES PLANES THAT MAKE HISTORY

GRUMMAN AIRCRAFT ENGINEERING CORPORATION
BETHPAGE · LONG ISLAND · NEW YORK

CARGO *without Convoy*

Linking globe-strewn Navy Bases, Consolidated PB2Y3's are speeding indispensable personnel, imperative matériel, and V-mail on a world express system. Curtiss Propellers give these Navy transports the many exclusive advantages of electric blade control.

CURTISS

ELECTRIC PROPELLERS

17—AND THE AAF

The enlisted reserves offer an opportunity for young men to prepare for flying service.

Aviation cadets are given classification test to determine their aptitude for pilot, navigator or bombardier training.

IF YOU'RE a young American, 17 years old, not yet turned 18, this article is particularly for you. The roar of planes that are beating the Axis may be hammering the message of your future in the air.

There are 1,250,000 of you 17-year-olds in America. That is more than there are people in Seattle, Denver and Buffalo combined. Each month, almost 100,000 youngsters become 17 and join your ranks.

Most of you will be in service—and a lot of you will be serving with the Army Air Forces.

To help you choose your career, to help you prepare wisely *in advance*, the Air Forces need *your* help. You already know something about air power. You can spot a *Lightning* or a *Mitchell* with a speed and accuracy that startle your dad. You realize the fast-growing AAF is training pilots, navigators, bombardiers, gunners and all the rest of them—and at a rate no other nation ever tried before.

You're impatient, of course. If you're normal, healthy and 17 years old, you're not waiting to be told your future is in the skies of the world. You want to get at it. You want to be *doing* something.

And the AAF says: Wait.

Stay in school—or on the job. Get sleep. Eat right. Play hard. Keep fit to get tough.

The AAF isn't pampering you. The Air Forces are in a hurry. They have a big job to do—a job that will run better if *your* aviation training doesn't start from scratch. If, in other words, you're ready.

How do you get ready—even before 18—to find the "best" spot you can fill in the AAF at war?

First you go to an Aviation Cadet Examining Board and apply for examination and enlistment.

Next, you get your parents' written consent for your enlistment in the Air Corps Enlisted Reserve.

"Enlisting" your parents as well as yourself is more than a formality. The Army Air Forces is the world's greatest team. It wants your parents to support you and this team to the limit —just as your dad cheers from the sidelines when you take the football field. The AAF wants them to know its safety record —the world's best in point of flying hours.

But most important, the Army Air Forces insists on *complete* training before you go into the skies. Your father and mother should know this.

With enlistment, and with silver-and-blue lapel insignia to show for it, you're on inactive status at least until your 18th birthday. You can continue school or civilian job as you choose. You can even specify a later date for active service—any time up to six months after you're 18—if you do this at the time of your enlistment.

Meanwhile you want to get busy. And when the AAF says "Wait"—it doesn't ask you to sit idly by.

By all means finish high school. And take on a full load of the "scientific" subjects—especially math and physics. This may seem hard, with a war to be won and not a minute to lose —and you wanting to get in there and pitch.

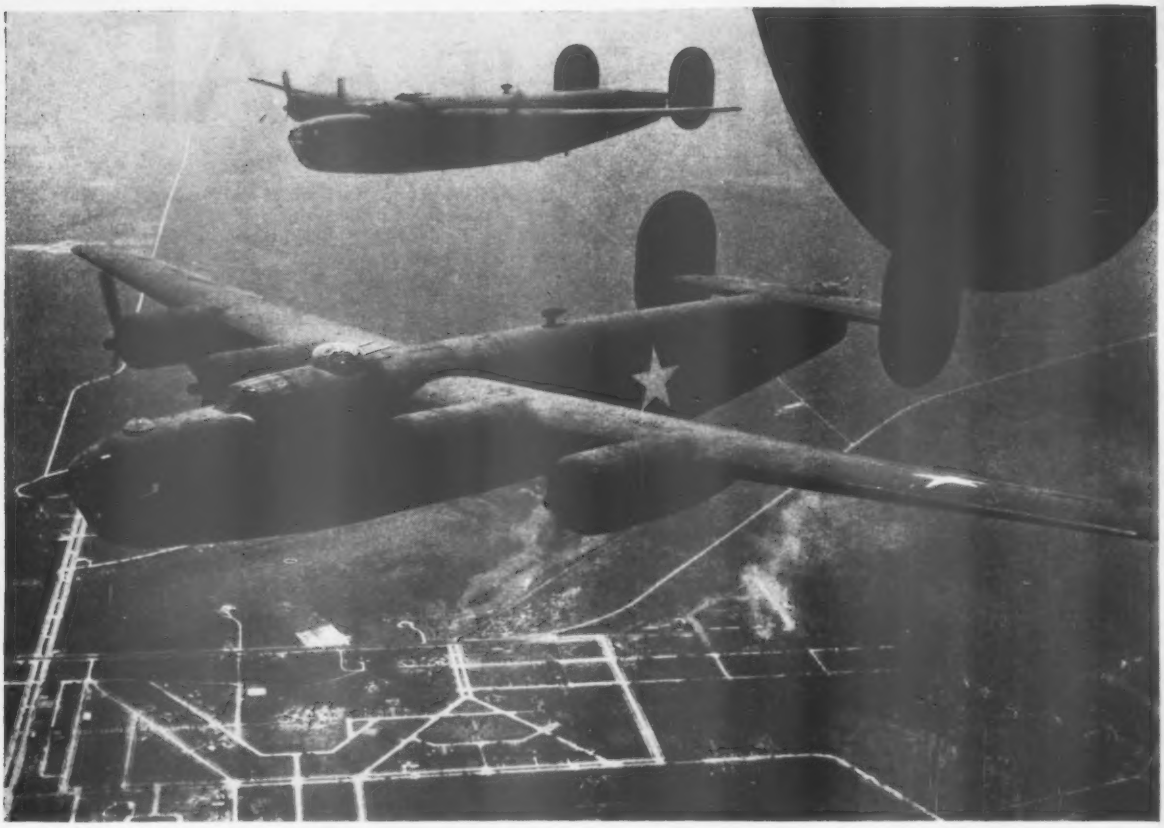
Just remember what it takes to guide a bomber hundreds of miles into German or Jap territory, with only stars as signposts. Every bomber mission involves more higher mathematics than most college freshmen even dream of.

Bone up on your English and history. In an AAF that's operating everywhere in the world, *you* may have to deal with foreign statesmen, native tribes, or perhaps enemy prisoners. How you talk and act can help or hurt America in that quarter. You'll want to express yourself well, and to know what brought on the war and why we're fighting.

Some schools even provide shop work and pre-flight aeronautics.

The main thing is to keep your mind alert as never before. You're not trying for just grades, now. You've got a future to consider—and the harder you attack the preliminaries, the

(*Continued on page* 292)



Pilots master the Consolidated "Liberator" at a transition "post-graduate" school conducted by the Training Command.

THE TRAINING COMMAND

United under one command, the AAF's technical and flight instruction systems now comprise the world's largest educational institution.

WHEN the War Department on July 7 merged the AAF Technical Training and Flying Training Commands into one organization called the Training Command, it pooled two of the most extensive instructional systems into a super-command without equal in size or scope. The move constituted the blending of two paralleling organizations so that they might dovetail into one smooth production line of air power. The teamwork expected of flyer and mechanic was extended back to the systems which produced them.

Stated purpose of the change was to achieve "maximum economy of operation, more efficient utilization of personnel, and maximum co-ordination of training schedules and use of training facilities."

The Flying Training Command had grown from the operator of only two training centers—Kelly and Randolph Fields, Tex. —in 1939, graduating 500 pilots annually, to an organization of 45 fields turning out 100,000 pilots in 1941. Its headquarters at Fort Worth, Tex., now have become the headquarters for the new Training Command under the leadership of Maj. Gen. Barton K. Yount, its commanding general.

In the 28 months of its existence since March, 1941, the Technical Training Command, largest of AAF commands, had turned out more than 500,000 ground and air combat crew technicians. In the 20 years between 1921 and 1941, by contrast, the Army Air Corps had graduated only 14,803 such technicians.

Flight Training

Three training centers, each with four training wings, divide this empire of men-in-training. The Southeast Training Center extends from Maine to Florida, from Louisiana to Wisconsin. The Gulf Coast Training Center covers the mid-continent states from North Dakota and Minnesota to the Gulf of Mexico. The

Ability of the prospective cadet to operate two controls simultaneously is tested by these matching boards.

West Coast Training Center includes the Rocky Mountain area and far west. That is the framework of pilot, bombardier, navigator and gunnery schools dotting the southern half of the country. The flight branch of the Training Command gives young America a tuition-free education and the world's finest flying training, worth from $25,000 to $30,000.

In order to increase the output of the training program, a college training program of five months' duration has been put into effect. Under it future airmen receive 700 hours of academic and military instruction prior to entering centers to be classified for air training. With a military staff serving in an advisory capacity, such training will be conducted without interruption through the regular curriculum of accredited colleges and universities in all parts of the country.

Students are enrolled in the courses as privates, receive instruction in mathematics, physics, current history, geography, English, civil air regulations, plus military drill, regulations, discipline and customs. Further, each student gets 10 hours of instruction in lightplanes. On completion of his five-month course, the student goes to a classification center where his future will be decided—pilot, navigator or bombardier.

A would-be airman receives a thorough physical and mental check-up at the classification center, to which he is first assigned. For a period of three to five weeks he is subjected to tests designed to determine his aptitude for one of the vital Air Forces jobs.

Air surgeons give him a stiff medical going-over. Then comes the famed AAF "screening"—expertly devised aptitude tests slanted at flying ability. The youth also tries his hand at written exams ranging from mathematics to vocabulary and map reading.

He enters "the house of gadgets," where he takes "psychomotor" tests. He holds a stylus in a pinhole to test the steadiness of his nerves.

Expert psychologists recruited from the nation's leading colleges probe and test his mind and muscles, his character and temperament. The young cadet is classified for the job for which he is best suited by nature and by ability. Valuable time, money and manpower are thus saved by fitting round pegs in round holes.

For the nine weeks at preflight school the cadet engages in an intensive bout with strict discipline, military customs, courtesies and drill. He gets his first introduction to courses in aircraft and naval vessel identification.

He studies international Morse code and field strips a Tommy gun. In the low-pressure chamber he "flies" to 28,000 feet, and practices the use of oxygen equipment at high altitudes.

When he leaves, he's more sure of himself in a world where honest confidence counts. He knows how to march. Physical training has taken the bow from his spine and the lard from his middle. He has a respect for authority—and the urge to fly, to navigate, to shoot, to bomb. By tests and preference, he's headed for one of these specialties. First, let's consider the future pilot.

The Flying Training Command clipped valuable training time when it established the preflight school system. Through the civilian-operated elementaries, the Air Forces utilize the facilities and experience of civilian flying schools, saving most air officers for basic and advanced phases.

On his first ride, the cadet gets about 30 minutes in the air and has his first chance to follow through on the controls. By the end of the initial week, he can hold the craft in level flight and make a few climbing turns. In another week, he's making landings and take-offs. By the end of that week, he may be ready to solo if he had previous flight training. But the general rule is: no solos under eight hours' dual flight.

He learns "stages," acrobatics, map reading, the use of landmarks. And he gets five hours in the Link Trainer—the earth-bound cockpit in which future pilots learn instrument flying.

After 65 hours in the air, and many more hours in classrooms

Aviation cadets prepare to take off in North American "Texans," Vultee "Valiants" and Cessna "Bobcats."

and "hangar flying," the cadet is ready for basic flying school.

In his minimum of 70 hours at basic flying school, the cadet learns accuracy and the meaning of sky discipline. He flies three-ship "V" formations, chandelles, lazy eights, makes simulated forced landings, learns to "set her down" in almost total darkness.

On the ground, the cadet studies radio code, blinker signals, the interphone system. He's warned not to shout into the mike, must learn all radio operations aloft. For approximately 35 hours, he draws weather maps, interprets weather reports, studies cloud formations and "fronts," and learns the weather most favorable for pouncing on the enemy. Basic is the big hurdle. From basic to advanced school seems easy. The cadet has had 130 hours in the air.

If he has been classified as a fighter pilot, the cadet is ready for a single-engine advanced school where he will fly a North American *Texan* and take a crack at a Curtiss *Warhawk*. If he has been chosen for bomber training, his path leads to an advanced twin-engine school, where he masters a Curtiss *Jeep*, Beech *Wichita* or Cessna *Bobcat*, cabin ships with two engines and the characteristics of bombers to come.

The mission here is to train men to be fighter pilots, to teach them to use the airplane as an aggressive, death-dealing weapon. The advanced cadet learns to shoot, and in the final phase of his course masters some of the lightning-like tactical planes he'll fly in combat. The cadet first flies missions in the 6000 h.p. *Texan*, later in tactical planes, learns basic navigation and tricks of combat.

More than ever before, fixed gunnery is being stressed for the wartime single-engine pilot.

On the skeet range, the cadet learns to "swing on and lead" the target. He gets an introduction to the deflection and range estimation trainer—an airplane seat assembly with gunsight and control stick, a beam of light, a landscape-painted backdrop. An electric eye records his scores.

The cadet fires a BB gun with an aerial gunsight from his seat in a pitching Link Trainer. He sharpens his aim on the famed gunsight aiming point camera, and when he finishes this training, he harmonizes the play of aircraft machine guns on a real powder-and-lead range. Finally, the cadet gets his chance to put holes in a towed target of white wire mesh, blasting the mock enemy high in the air.

Although he'll get his final examination as a combat fighter when he enters an operational training unit, the advanced cadet knows his plane and his job by the time he pins on his wings. He is a finished product.

Because his job will be to fly planes with longer ranges, at twin-engined advanced school there is more stress on navigation. From fields throughout the nation, twin-engined trainers fly daily practice missions, despite storms, fog, wing, or strange terrain. Men selected for medium bomber work also get six hours of gunnery in order to be able to direct the fire of their combat planes' fixed machine guns.

From twin-engined advanced, where they received their wings, the young flyers go to "post graduate" twin-engine or four-engine schools to fly the type of bombers they will use in action. When they leave this stage, the North American *Mitchell*, Martin *Marauder*, Douglas *Boston*, Consolidated *Liberator* or Boeing *Flying Fortress* are familiar friends.

Prior to combat, a student pilot is assigned to an Air Force operational training unit, not under the jurisdiction of the Training Command, to fit him into the mosaic of a fighting or bombardment squadron. Here he learns the life-and-death meaning of combat teamwork.

It's approximately 62 weeks from the time a future airman reports to the classification center until that day when he leaves an operational training unit for combat duty. War's job, for him, is just beginning.

Meanwhile his teammates—navigators, bombardiers, aerial gunners—have been learning their jobs. A scant few years ago, pilots got home with only a compass and the earth's surface to guide them. But planes began to fly faster and farther—too fast and too far for primitive signposts. Aerial navigation became an exacting science that allowed no margin for error.

Today, at specialized schools of the Training Command, selected young men from classification centers are learning to "get 'em there and get 'em back."

Even in training missions, the cadet must navigate so well that he'll arrive with his plane at the end of a 500-mile jaunt within $4\frac{1}{2}$ minutes of the ETA (the estimated time of arrival).

The navigation cadet learns four methods of guiding a bomber across a continent or ocean:

Pilotage—the use of a well-marked map and obvious landmarks on the ground—is the simplest. But there may be no reliable maps for camouflaged Germany or Japan, and the mission may be performed from such an altitude that distinguishing features below are ill-defined.

Dead reckoning, the second method, compares speed and known distance, thus estimates when and where the plane will arrive. For this the cadet needs such tools as these: a pencil, watch, drift meter, Mercator chart, airspeed indicator, altimeter, computer, compass, and a free air temperature gauge.

A third method is use of the radio range and the radio compass with which "*radio bearing*" is taken. But for operations over enemy territory there is no radio "beam" to lead the invader to his target.

For certainty over every inch of the earth's surface, the cadet studies the stars. This is exacting. It also wins battles. In *celestial navigation*, the cadet makes a sextant's acquaintance with Polaris, Sirius, Betelgeuse and 52 other trustworthy stars —the sky's guideposts to Yokohama or Dusseldorf.

Armed with a sextant, a Mercator chart, a Weems' plotter, a computer, pair of dividers, an air almanac, book of tables called "H. O. 218," scrap paper, log book and pencil—all carried in a brief case—the trained navigator can guide a bomber to any target of global war.

In twin-engined planes equipped as classrooms, cadets work actual problems in combat navigation—including detours around antiaircraft positions. In all, the student navigator spends 100 hours in the air.

Navigation cadets are sent from preflight centers to gunnery schools before their actual navigation training. The AAF at war is determined that every navigator and bombardier be able to defend himself and his teammates by manning a gun if need be. The seven-week gunnery course must be completed before combat duty, and more than half of the student navigators and bombardiers now get this training before they are sent to operational training units for air crews.

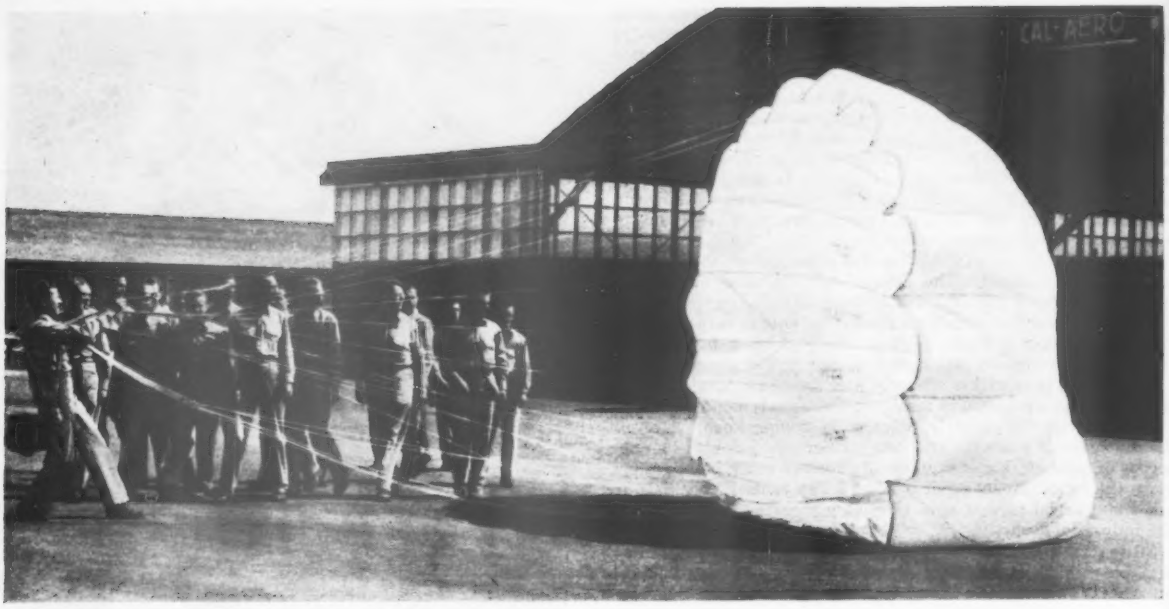
In the bomber crew, the ultimate objective of the nation's air power is realized. The genius and labors of millions of workers and the expenditure of billions of dollars culminate in the bombardment mission that blasts the enemy target. If the AAF fails to get a bomber above the enemy, if bombs miss their target, America's labors and money go for naught.

Bombs and bombsights are only half the story. Student bombardiers work problems in mathematics, aerodynamics, physics and navigation, until their reaction is trigger-keen. Aircraft identification is vital, for the bombardier often doubles as observer or gunner. Experts on enemy surface craft, bombardiers learn the exact impact point to blast a Jap cruiser. They study maps and aerial photographs of enemy targets—Berlin, Tokyo, the industrial Ruhr.

Sitting in a 12-foot "high chair," a cadet tries his accuracy first by miniature bombing of an electrically-operated "bug" on wheels below. The "bug" scurries about on the floor beneath the trainer, just as an enemy battleship twists to avoid a U. S. bombing plane. When the bombardier releases his "bombs", hits are registered automatically on the tiny target's surface.

The trainee is taught hand-to-hand knife combat.

Three aviation cadets take the inclined board obstacle on the "commando" course at Williams Field, Ariz.



Instructor demonstrates ground manipulation of parachute to a class of riggers at a Training Command school.

The student goes aloft for "dry runs," later turns loose 100-pound sand-filled bombs to score practice hits. As graduation nears, he has become accustomed to dropping live bombs under simulated combat conditions.

That manpower may be used to the full, all bombardiers are required to complete a course in dead reckoning navigation. Picked bombardier students also are given celestial navigation training, in order to assist the navigator to and from the target. The bombardier's work may be crammed into 15 minutes of intense activity. During the "en route" parts of the mission he is free to double as navigator or gunner—a vital addition to air crew training if the navigator should be killed.

"It's the tail gunner who takes it on the chin when the Zeros come in," Gen. Henry H. Arnold once said.

"The gunner always has been appreciated by the Army Air Forces as such; now we also give him aircrew wings to identify him everywhere as 'gunner.' "

General Arnold's statement points up the gunner's vital role. The enlisted gunner is the "formidable" part of the "formidable *Fortress*" or *Liberator*.

Courses at the gunnery schools of the Training Command begin with lessons in firing a small BB machine gun that spits lead pellets at the rate of 600 a minute. With it the novice can fire bursts at moving airplane silhouettes without wasting more valuable ammunition.

Next comes a workout on a standard .22 rifle range, and later an introduction to the skeet range where the new gunner blasts away at clay pigeons—first from a standing position on the ground, then from the back of a truck bouncing down a rutted road.

Synthetic training devices include the standard turret sight. The cadet fires spots of light with a photoelectric gun. A meter records the number of "hits" and an automatic noise-maker supplies battle "noises" for combat to come.

He first shoots real machine guns, the .30 and .50 calibers, on the ground ranges where he fires on targets which are atop driverless jeeps which run about on a track before his turret-mounted guns. He also works out on the malfunction range and learns to repair his gun quickly in the event of a breakdown.

Finally, the gunner goes into the air to shoot at towed targets, first from the cockpit of a trainer and then from the turrets of an actual bomber.

The future marksman gets many hours of actual firing instruction and shooting—and many more hours in classrooms, learning the 200 parts of a .50 caliber machine gun and how to adjust and use various sights, and simple formulae necessary for sight adjustments. And he spends hours learning to identify all the world's aircraft by a simplified "flash system" of recognition.

Passing on lessons learned in actual combat and consolidating the experience of training schools throughout the nation, the Training Command's instructors schools loom as valuable adjuncts to a progressively more effective system of aerial education.

After 15 years as one of the Army Air Forces' best known flying centers, Randolph Field drew the assignment to train Air Forces instructors for the entire nation. Instructors had always been good flyers. But that did not necessarily mean they were good teachers. Nor that they taught the same things in the same way. For instance, there are many recognized ways to do a "stall" in an airplane. Conceivably, different instructors might teach students different ways of executing the same maneuver.

So Randolph was given the job of standardizing instruction and of literally instructing instructors.

The school is divided into six parts, primary, basic, single-engine advanced, twin-engine advanced, ground school and school for military commandants.

Student-trainees for basic and the two advanced flying schools are selected from the top third of advanced training fields throughout the nation. Their course lasts one month and into it is crammed 60 hours of highly technical flying, psychology of teaching, analysis of maneuvers, the study of structural aircraft, theory of flight and other less stressed subjects. The future instructors are taught not only how something happens but why.

The primary course is attended by civilian pilots, either sent from Government contract schools or headed for them. This course lasts two months.

The ground school teaches commandants of cadets, teachers for ground school subjects and also feeds the pilot his ground information.

At Bryan Army Air Field, also in Texas, is located the instrument school for instructors.

Central Instructors' School (bombardier) located at Carlsbad, N. M., serves as a clearing house for processing all vital information pertinent to the instruction of bombardier students. Regularly assigned bombardier instructors are sent into this school from their own bombardier schools to pursue a course of "higher education." The subjects covered are advanced instruction in all phases taught at the bombardier schools plus a practical application of this knowledge under the guiding hands of bombardiers recently arrived from theaters of operation.

The nation's outstanding marksmen form the "faculty" at the

The armament school teaches power turret repair.

Assembling some of the 200 parts of a machine gun.

Communication system of a "Fortress" is disassembled.

Gunnery Instructors' School at Fort Myers, Fla., where the lessons of war and the results of long experience are passed on to those who will teach the trigger-men in America's bombers how to aim and shoot. A number of training aids have been developed at the relatively new school. That the gunnery training program is most efficient is proved daily by reports from overseas.

A central instructors' school for navigators is now in the process of organization.

In increasing numbers, America's "future generals," graduates of the U. S. Military Academy at West Point, N. Y., request assignment to the Air Forces for training as pilots. In October, 1941, the superintendent of the Academy requested a plan of training for the institution's air-minded cadets. In response, General Arnold outlined a complete course of instruction, vesting administrative control and responsibility in the superintendent and technical control in the commanding general of the Training Command. Necessary directives were issued early in 1942, and today basic and advanced training is given at nearby Stewart Field. Primary training is received at the civilian-operated detachments to which other aviation cadets are sent. Approximately 40 per cent of each class at West Point today seeks flying training and, of that number, all but an average of 10 per cent are selected.

An important addition to the training program was the initiation of a school for Negro aviation cadets at Tuskegee, Ala. These capable young Americans receive primary, basic and advanced training, and transition to tactical planes. Already, early graduates of the course have been organized into a formidable combat unit and some of them have already seen action against the enemy.

Ready for their mission in carrying troops into the backyards of the enemy, thousands of glider pilots have been trained and await only the signal for action. Others are busy as students, landing lightplanes with no power and slipping silently through the clouds on gliders' wings at the advanced glider school of the Training Command.

The liaison pilot, whose unheralded but highly important duties are performed in lightplanes, concentrates on behind-the-lines observation, patrol and message carrying. Specialized schools in the Training Command are turning out these winged messengers by the hundreds.

The importance of women in wartime military aviation was emphasized last year with the inauguration of a women's pilot training program, under direction of the Training Command. Women students between the ages of 21 and 35 receive a special course of flying, stressing navigation. Calisthenics,

(*Continued on page* 244)

SAVING AIR CREWS

Self-inflated life rafts used by AAF carry food, fishing tackle, radio, flares, first aid kit and a sail.

THE Army Air Forces "secret weapon" might well be the work of Flight Control Command.

This organization—so young that its very existence is news—colors every estimate of U. S. air power. There's a reason. Each pilot and combat plane saved from a "routine" crash is an added blow against the enemy. On the other hand, Hitler and the Jap win a victory with no cost to them whenever we lose a man or a plane before they reach combat.

Flight Control Command was organized to do these things:

1. To teach.
2. To guide.
3. To rescue.

Before a student pilot leaves the ground, lectures, motion pictures and cartoons begin the teaching process. Gone is the idea that the "hot pilot" is a hero. This war has no place for "flying fools."

Most students learn the lesson well. They acquire team spirit that means thinking of the other fellows, flying with your head instead of by the seat of your pants. In other words, the great majority of pilots trained by the AAF today need merely be told *what* and *how* to fly. Their own common sense tells them *why*.

Yet air operations on a world scale require more of a pilot than the right start. The most earnest flyer, unaided, can't hope to do his job without guidance.

There's always weather. This war has found its hottest battlefronts in places where fogs smudge the horizon, monsoons sweep the jungle, blizzards whip down from the North, and sand storms choke and blind.

There's a growing body of "laws of the air" which airmen call AAF Regulations. This "pilot's bible" is too massive for any one man to absorb completely.

There's the sheer volume of air traffic, whether it be a bomber base in England or an aircraft transfer point bordering our vast aviation factories. Even before combat, a flyer may fall victim to man and nature unless someone guides him around storms, flashes the green light in sky traffic, digests for him the rules of the air.

Flight Control Command does all these things and more.

Pilots may get expert guidance, yet find themselves forced down in a jungle or on a glacier because of freak storms, enemy action or other good reasons. It's the job of Flight Control Command to go and get that man and also his plane, if possible.

The Command was created last March by Gen. H. H. Arnold to help pilots "get there and get back"—with an accomplished mission in between.

War's need forced this change. The Command is a fusion of several former AAF directorates, plus some new functions. The AAF's unprecedented expansion had created new problems of military air control and traffic and magnified old ones. The man who holds the reins as commanding officer is Col. Samuel R. Harris, Jr., West Pointer, command pilot, veteran test flyer and holder of the Distinguished Flying Cross. Functions of the Command are six: flight control, weather, communications, air-sea rescue, flying safety and safety education.

The Flight Control unit was created to assist young AAF pilots who have, in Colonel Harris' words, "more guts than

Airmen faced with sudden emergencies are taught self-preservation by the newly created Flight Control Command of the AAF.

One-man parachute boat, attached to pilot as seat-pack, inflates in few seconds at the turn of a valve.

experience." Flight Control is centralized supervision of military point-to-point flights.

At the outset, Flight Control revised pilot clearances and worked out uniform operations procedures for all AAF bases. Operations officers in the field now get fresh publications, maps and weather sequences without delay.

By arrangement with the Army, the Civil Aeronautics Administration airways traffic control schools help to train Air Forces officers on control technique for point-to-point flight. These officers staff the airways traffic control centers across the country as advisers to operations offices. They're not policemen. Instead, FCC personnel move in next door to base operations and wait to be asked advice. Operations officers, as always, are responsible for clearance, but FCC supplies the latest weather and traffic information for a sound flight plan.

In brief, FCC uses every means science can devise to insure safe, regular operations. Today, in the midst of a war of unparalleled ferocity, experts predict weather conditions everywhere, maintain contact with every AAF plane in flight, marshal an unseen army of signals and warning devices to make arrival almost certain.

But suppose the weather, despite our planning, goes into a tantrum. Suppose enemy aircraft, despite our defenses, make a freak stab across our airways. Suppose sudden illness seizes a fighter pilot; or mechanical failure, caused by a freak of climate, hits a bomber. Anything might happen. Many things do. This is where air-sea rescue has become an extra quality of U.S. air power.

Still in the making, air-sea rescue is the biggest salvage operation ever undertaken. Squadrons already activated are made up of aviation experts, pioneers in far places and men who have been through the hell of emergency landings—and lived. Week by week more squadrons are being trained and scattered across the frontiers of air war. These rescue specialists operate in combat theaters, along air transport routes, up and down the U.S. coasts and on the fast-shifting fronts.

The Air-Sea Rescue Wing of FCC is rushing the activation of Arctic squadrons. Personnel will include pilots, navigators, communications officers, medical experts, dog-team handlers and drivers, and expert ground crews.

The ground crews include trained, tough mechanics, dope and fabric men, radio repairmen and parachute riggers. Each

(*Continued on page* 336)

1 FTC illustrates safety steps for pilot downed in water in burning plane. Jumping feet first, pilot covers face with both hands, takes a deep breath.

2 If endangered by flames, pilot splashes flames away from body, deflates life vest and swims under the water until he thinks he is clear of danger area.

3 In coming up for air, if flames still surround him, pilot repeats previous procedure until he is out of the danger area. He then re-inflates his life vest.

Poor eyes must not get by the medical examiners—they can be responsible for a bomb miss or a plane crackup.

AVIATION MEDICINE

The flight surgeon watches over the physical and mental condition of his aircrews with the solicitude of a parent.

AVIATION medicine in the wartime Army Air Forces means many things—things as different as a huge, immaculate base hospital and a litter beneath a palm tree. Aviation medicine is the selection of top-flight American youth for bomber air crews, the delousing of native villages in Africa, the shipment of blood plasma to Greenland.

It's a whole catalogue of functions with the flight surgeon in AAF squadrons and groups bringing aviation medicine to battle.

The flight surgeon in this war is a man of action. He goes with troops and flies an occasional mission. His laboratory is the sky and guns and planes.

Because this air conflict is limited only by the sky there are no limits beyond which an aviation doctor can say, "This is for the other man to do."

When we recall the centuries of human evolution we see how brief the history of aviation has been. Within this one century men not only have risen off the ground: they are going faster and higher with all the energy the human body will allow.

Are we reaching our physical limits in this war? Are there speeds and altitudes beyond which no man of today can live?

These questions aviation medicine must answer—not once or twice or three times, but as often as aircraft designers and war's pressures demand.

The AAF flight surgeon must begin by selecting aviation cadets and must check and re-check combat pilots throughout their careers. He makes certain that no diseases threaten our fighting men even if this means teaching whole nations the simple laws of hygiene.

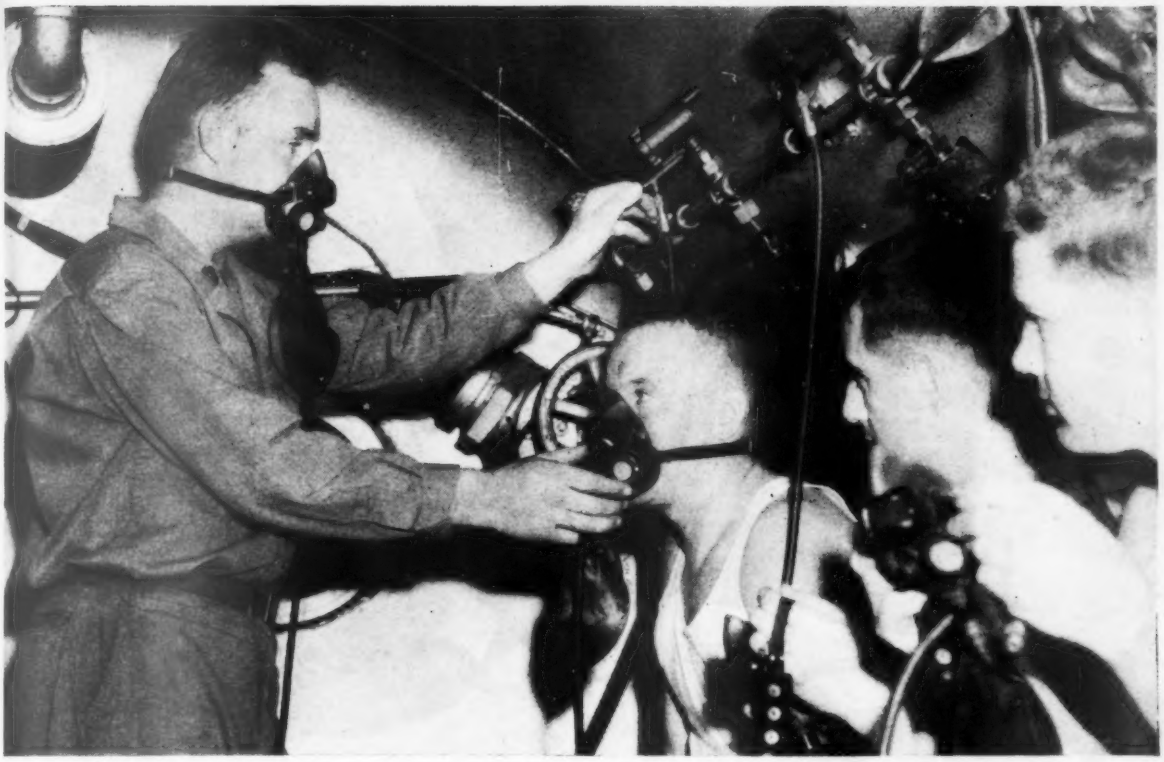
Are we to exploit the advantages of transpolar flight? Then aviation medicine has to discover what extremes of cold the human body can endure, to determine the design of aircraft sealed for comfort and efficiency. It must prepare and have available medicines and supplies for Arctic emergencies.

Can we natives of temperate zones drive the Jap from the South Seas and extend our supply routes from South America to India? Then we must be prepared for desert heat and jungle humidity. Experts on the human body in flight must cope with exotic diseases, climatic extremes and pioneer hardships.

Aviation medicine has become the doctor of the world. What kind of a man is this AAF doctor?

He must first of all be a competent physician in the usual sense. He must be skilled in surgery. He must bring the Air Forces this background from civilian life. Many a famed specialist, many a crossroads doctor has heeded the AAF's need.

But the AAF asks more of a man than mere professional ability. He must be a psychologist and father-confessor, too. He must have the intuitive sense to know airmen's problems and what to do about them. Medicine in bottles will do nothing for a pilot who is jittery from the strain of overmuch flight. No surgery will help a bomber crew whose temperaments explode.



Oxygen masks are worn above 10,000 feet. Here, in a training tank, instructor helps airmen learn to use oxygen.

He must know when to encourage, when to be blunt, when to joke, when to advise. He has to understand—by living close to his aircrews—how much each man can take, what quirks of personality each has. There can be no favoritism. In the flight surgeon's keeping are the flying careers of Air Forces men. His word is final on fitness. Tragic accidents in aviation's infancy proved for all time that no man who is sick or emotionally upset has the right to fly.

The flight surgeon has an obligation to his Government and his profession, to every man who wants to fly and is not fit to fly. He has an obligation to parents to forbid that man to fly if he is not fit. The Army Air Forces can not waste time, training and money on him. They dare not jeopardize the crew that might be on an unfit pilot's plane. The airplane itself is too costly for unfit handling.

Aviation medicine deals not only with the selection, the medical supervision and maintenance of mentally and physically efficient flying personnel, but also psychological and physical selection.

The psychiatry of warfare is more important than ever before. In air war particularly, the tempo has quickened to the

(*Continued on page* 213)

Beneath the African sun, an AAF dentist hunts a cavity.

Oxygen units are a responsibility of aviation medicine.

Crew members of the 9th Air Force are interrogated by air intelligence after a bombing mission over enemy territory.

AIR INTELLIGENCE

AIR Intelligence is a red-hot firecracker. Yet of all topics in wartime, military intelligence is the one least discussed. The full story can be told only after this war—or after all wars.

The results of the work of air intelligence, however, already are plainly evident even to the untrained eye. No neater example of its efficacy can be cited than the Sicilian campaign in general and the raid on Rome in particular. The *general* intelligence services of both our own and the British governments were well aware of the general situations in Sicily and Rome. They knew just where and how the "soft underside of the Axis" was softest.

But where to hit those spots was very largely the work of *air* intelligence. For instance, it was a subject of general intelligence's task to know that the marshalling (railroad) yards in Rome were used to carry troops and supplies to Sicily and southern Italy. But it was the work of air intelligence to spot those yards on maps and photographs and to supply our specially trained bombardiers with information so accurate that they could hit these military objectives without hitting the priceless storehouses of culture and religion scattered throughout the city of Rome itself.

The story of how it was done has been told in detail. It was no easy trick to demolish the San Lorenzo railroad station and spare the historic church of San Lorenzo nearby. The railroad terminal was demolished, utterly. The church of San Lorenzo was damaged. But, as Pope Pius XII himself testified in correcting the Axis propaganda use of his first pronouncement on the bombing, it was not destroyed. And it was the only one of the vast collection of historic spots in Rome which was even damaged.

Many of the men who aimed those bombs had been frequent visitors to Rome. But to walk about a city's streets is a very different thing from flying over those streets at from 10,000 to 40,000 feet altitude. Fly over your own city some day and you will see how different it looks. It was air intelligence that put into those bombardiers' minds a picture—a chart—of the city of Rome so clear and so definite that they could correctly carry out their instructions to hit military objectives and military objectives *alone*.

So, too, it was in the invasion of Sicily. Air intelligence, looking down from its third dimension and making photographs, was able to supply the high command with an exact list, description and picture of those places on the south and east shore of the island and their defenses. On that kind of intelligence the Army and Navy were able to build their schedule of invasion.

The greatest armada in history, more than 3,000 ships, was

Viewing topographic photographs through the stereoscope provides third dimension and a clearer outline of terrain contour.

Like a surgeon's probe, air intelligence seeks out the precise spot on the enemy's armor to be slashed by co-ordinated attack.

dispatched from Africa on a precise schedule. Each ship and each landing barge was to land at a definite point at a definite time. Thanks to air intelligence and its photographs those points could be chosen and instructions given to each barge commander as to just the kind and amount of resistance he could be expected to meet. And in most instances he could be given actual photographs of the terrain in which he was to operate—all thanks to air intelligence.

As the campaign progressed that intelligence was constantly supplemented. Scarcely an advance was made without the detachment commander having a precise picture of the formations and defenses against which he was ordered to advance.

Only air intelligence, based on control of the air over enemy lines, can give this precise information. Elsewhere in this issue is a series of pictures showing how air intelligence photographed a Sicilian airport with more than 100 planes on it. Other pictures of that series show the way our Air Forces took advantage of such air intelligence. They show that more than half of those enemy airplanes on the ground were destroyed. Thus air intelligence actually made possible that control of the air by the destruction of enemy airplanes, by virtue of which it was enabled further to continue in business and further to serve not only our air but our ground troops.

Battlefront reports from Sicily are full of stories of how air intelligence further served. Air intelligence spotted enemy tank, artillery and other concentrations and enabled the artillery and the naval guns to clear the way. Air intelligence, in other words, saved the lives of thousands of American boys. Without air intelligence it is doubtful if the invasion could have been so successful. Without it the Allies, not knowing what they were up against, might have hesitated at the southern shore of the Mediterranean as Hitler, in 1940, hesitated at the southern shore of the English Channel.

Mr. Churchill and others have long ago testified that, had the Germans known how pitifully weak British defenses were in the tragic days after Dunkirk, they would not have hesitated. But German air intelligence was not able to provide this information. Hitler did not know. England was not invaded. The low point of anti-Axis fortunes became the turning point.

As the march goes on, to and into Hitler's "Fortress Europe," air intelligence will play its part in assuring that Allied thrusts are aimed at no idle or foolish objectives. For air intelligence is not only the observation of current positions from the air, it is the collection of all previous knowledge of those objectives and the circumstances surrounding them. It is supplying to our strategic bombers, to our tactical air force and to our ground troops everything that a soldier needs to know to lay his plans intelligently and successfully.

Two basic articles on the subject have appeared in recent issues of FLYING. One was by Comm. Frank W. Wead, USN, and the other by Air Vice Marshal Charles E. H. Medhurst, RAF. They indicate that intelligence officers obtain information from such sources as the close analysis of aerial photographs, the reports of bomber and fighter crews, other visual reconnaissance, reports of agents inside enemy countries, examination of captured personnel and materiel, and the military intelligence systems of friendly nations.

AAF intelligence officers use all these sources—and augment them with many more. Actually, they are pioneers in air intelligence work—the developers of many of the techniques and special apparatus now in use by other services and nations.

They do have one great advantage. They started first. The AAF is the oldest air force in the world. In 1910-11, airminded officers in the United States Army procured and flew the first military airplane ever built. For 32 years our officers have pioneered in airplane photography, radio and electronic devices —many of them secret—for obtaining and reporting that kind of complete information about the enemy known as intelligence.

Sometimes the information is short, like the flash report that warns of the approach of an enemy force. Often it is long and highly detailed. But in any case it must be *exact* and it must be in a form capable of *instant* comprehension by the commander who can use it. In the tempo of modern air warfare a misunderstood message can be fatal.

Split seconds count for as much in modern war as hours counted in the days when troops marched 2½ m.p.h. and warships plowed the seas at 15 knots or less.

From the man in command of a small air or ground unit to the chief of staff and the commander-in-chief, every commander in the United States Army uses Air Intelligence.

Airplanes surmount all barriers. There is no barrier—no mountain range or treetop—between the air observer's eye or lens and anything on the ground or water which needs to be photographed.

The darkest night is but a handy backdrop for a 1,000,000 candlepower flare.

As practiced by our Army Air Forces, Air Intelligence finds and analyzes the enemy wherever he is. It enables our commanders to inflict attacks upon him and at the same time neutralizes his efforts to employ surprise tactics against us.

Bombing crew reviews data provided by intelligence regarding nature of the target and expected enemy opposition.

Directed by proper intelligence we have seen AAF airplanes sink battleships and send entire convoys to the bottom. In 15 minutes they have smashed enemy installations which took many years to construct and tool.

Given accurate and sufficient intelligence, a commander's task is much simplified. There are times in war when he must stand toe to toe with the enemy and slug it out in a fight which often is costly in lives and materiel. On a large scale it can produce an almost hopeless deadlock like the trench warfare in France from 1914 to 1918.

When this war began the AAF set out to create the world's finest air intelligence system as well as the finest military airplanes, pilots, navigators, gunners, bombardiers, and engineering officers.

Somehow the AAF trained a small nucleus of hard-boiled intelligence and operation officers. Among them were graduates of the Command and Staff School, men seasoned by aviation experience all over the world, including many air veterans of our short, successful venture in World War I.

Experience teaches. Our air chiefs came out of that war with two convictions. First, that the airplane could become a marvelous instrument for reconnaissance and for artillery and infantry support. Second, that if heavily armored and equipped with specially designed bombs and bombsights, it would become a way to put "wings on shells," and carry them with precision to targets 50, 500, or 5,000 miles away.

You see what this implies. It implies knowing with equal precision exactly what targets to hit. And this is where intelligence staff work has its place.

And when the mission is over it is by no means completed. It will not be completed until air intelligence officers have analyzed each encounter with enemy aircraft, studied every shred of evidence of enemy defense tactics, mapped antiaircraft positions, plotted bomb damage, and estimated claims. As far as air intelligence is concerned, this attack will never be over as long as air war goes on.

Nor does a mission commence when the bombers take off from their bases.

Preparation for precision bombing of such strategic targets begins months, even years, before a mission. Air intelligence officers discover what resources best enable the enemy to make war, where they are located, how they may be struck with the most force and greatest economy of effort.

Does a ground commander wish to blast the reserves far behind his enemy's lines? Does he want to demoralize the garrison of a strong point until its will to resist is gone?

Intelligence staff work on such requests is handled by the intelligence officer (called S-2) of the squadron or group. He organizes intelligence before the attack. With the operations officer, he briefs the crews. He reports on each attack when it ends.

These reports go fast and far. All other American and friendly squadrons, air forces and ground commanders can be informed at once. Messages go by word of mouth, teletype, telegraph, couriers, and other ways.

There is another kind of intelligence work. An assignment comes to the air commander from a strategist who decides, say, that the enemy's production of Diesel engines—or electric lamps—is a factor in his continued ability to wage war. If so, will the AAF destroy a satisfactory percentage of all enemy factories where these vital articles are made?

Hundreds of such problems are referred to AAF commanders every week. Many can be solved by using ordinary maps. But there is much guesswork in such maps. To take out the guess the AAF started long ago to prepare a detailed objective folder of every industrial city in every enemy country. Germany, Japan and Italy all qualified for these researches 10 years ago.

Corrected often from fresh information, the most detailed aeronautical target charts not only show every air route to the center of enemy industrial cities, they also show the precise impact points for the American bombs.

Yet these charts, successful as they are proving, constitute but a small part of the total AAF intelligence staff preparations for war.

With the coming of war this staff was enormously increased.

Prior to take-off, crews are briefed by the intelligence officer with all data useful for the accomplishment of their mission.

Its men represent the pick of the newspaper business, the graphic arts and the professions in America—reporters, writers, artists, architects, other draughtsmen, lawyers, bankers, editors and analysts.

In a very definite sense, the Air Intelligence staff of the Army Air Forces is becoming one of the most efficient news-gathering organizations in the world. It is self-effacing, quiet, efficient, reliable.

Like all good reporters, AAF intelligence officers are required to get the news, the whole news, and nothing but the news. Every crumb of news, if true and "hot," can save the lives of airmen, soldiers and sailors and enable them to inflict more damage on the enemy.

In one typical bomber group the intelligence officer is a former newspaper man. Long ago he learned to write news stories that were essentially mission narratives, just as he writes now. He learned how to ask questions and get truthful replies. Now he is using that experience to pluck the meat from the stew of combat reports.

Consider another group. The intelligence officer is a major who was a pilot in World War I and then became a banker. Today his ability to put together and sort out credit information is making his intelligence section famous in its theater.

A third intelligence officer is a lawyer in civilian life. At his new stand he is up to the old business of asking people (combat crews now instead of witnesses) about the truth, weighing it, digesting it and summing it up into what he once called his "case," now calls "intelligence."

Of course, it isn't as simple as it sounds—this task of transforming specially talented civilians into air intelligence officers. They are put through severe training courses, crowding into 12 weeks or less the studies that AAF in peacetime might expect a man to accomplish in more than a year.

Most of the men are over 35. A few serve in Washington but nearly all members of this staff serve with air units in the field, for that is where the war is. Experience has shown that it is impossible to have too much or too good intelligence work in air combat, bombardment or advanced training posts.

The air intelligence officer is not the final analyst and user of the data he secures. He is assigned on definite missions to secure specific information for use by area commanders.

If he succeeds he presents this information as neatly and concisely arranged as possible to the commanders who can use it. Each commander can then make his decisions upon actual facts.

Behind the commanders are the technical officers and the airplane and accessory manufacturers. Studying data that is always fresh and reliable, these men goad our aircraft production to new peaks.

The air intelligence officer briefs combat crews before they take off, interrogates them when they return, keeps exact score on air operations, tabulates the exact results of every bombing attack and discovers every detail of the enemy's air, ground and naval strength, the location and movements of all his units. These are only a few of his main duties to which must be added counter-intelligence in all its forms. But that is a story by itself.

The air intelligence officer seeks facts about the enemy from photographs, from captured enemy equipment, prisoners, intelligence reports and summaries, liaison with other branches, sources within enemy territory, evacuees and refugees. He assimilates this mountain of information, brings it up to date, and points up details for his own combat crews. He uses ingenius training aids to impress the minds of combat crews so forcefully that the vital facts stick even in combat.

The intelligence officer of the group or squadron gives this information to the combat crews at a formal briefing, prior to take-off. The material must be complete enough for any emergency. It must also be pertinent to the job at hand. Crews returning from missions bring back a running story of fresh, always changing news. This is supplemented and confirmed by photo intelligence.

It is not regularly the duty of intelligence officers to fly into "the deep blue yonder." They are always eager to be taken on air missions and often they go along. For the most part, though, they must snatch what little sleep they can while the other men are flying.

The public will never realize what it owes to AAF intelligence officers in this air war. But the commanders and air crews know.

END

Bomber crew trainees learn the intricacies of the power turret, its gunsights and how to swivel it "around the clock."

AERIAL GUNNERY

The .50 caliber machine gun, the power-driven turret and our gunners' expert marksmanship are making aerial history.

UNTIL the super-gunned heavyweight bomber appeared on the scene, it was accepted doctrine in the Army Air Forces that the bomber had to have considerable fighter escort to accomplish its mission.

Now the bomber packs its own terrific punch, consisting of an assortment of flexible .50 caliber machine guns that have knocked down the enemy's guard of fighters from the banks of the Rhine to the shores of China. And that includes a lot of broad ocean where the bombers' left hand of .50's has often proved powerful enough to sink enemy submarines and surface shipping.

Naturally that terrific wallop didn't just grow. In the first place it depends on the proven virtues of the .50 caliber machine gun, which is an American development no other belligerent has yet been able to imitate successfully. It is only since Pearl Harbor that our planes have been generally equipped with this lethal left.

More important still, .50 caliber machine guns don't fire themselves. They have to be aimed in a way never before attempted. Some old sporting hands with a shotgun or rifle will tell you that it takes a lifetime to be a good duck shot and another lifetime to be a good hand on quail. The birds fly so differently, they say. Their speeds and directions are not the same. And the birds are so quick that you have to shoot by instinct.

Well, there are some thousands of American boys today taking just the right leads on birds that fly 10 times as fast as a duck or quail and in directions so varied as to make any bird dizzy. They are hitting them not from a firm stand on the ground but from airplanes flying as fast and as crazily as their targets. In other words, back of the .50's that make up our bombers' left punch, are boys shooting by an instinct trained to meet speeds and variations hitherto quite beyond the compass of the ordinary human senses.

Nowadays they are not the traditional American woodsmen. Most of them never had a firearm in their hands before they joined the Air Forces. A few have been hunters. But by far the most of them are clerks, stenographers, insurance salesmen, soda jerkers—all the varied types that go to make up American urban life. Practically all of them wanted to be flyers. But early in their Army careers, something turned up that indicated they would be better on the trigger than on the stick. And now that they have learned to shoot this new way, there has developed among them a pride of craft and an *esprit de corps*.

Their training has been one of the most difficult routines that the Army has had to devise. There was very little to go on, for shooting at one airplane from another at modern airplane speeds is something almost impossible to simulate. So a whole vast armory of new and strange devices, moving pictures, models, electric beams, sound effects, were brought into being. As a result, thousands of boys who have never smelt powder

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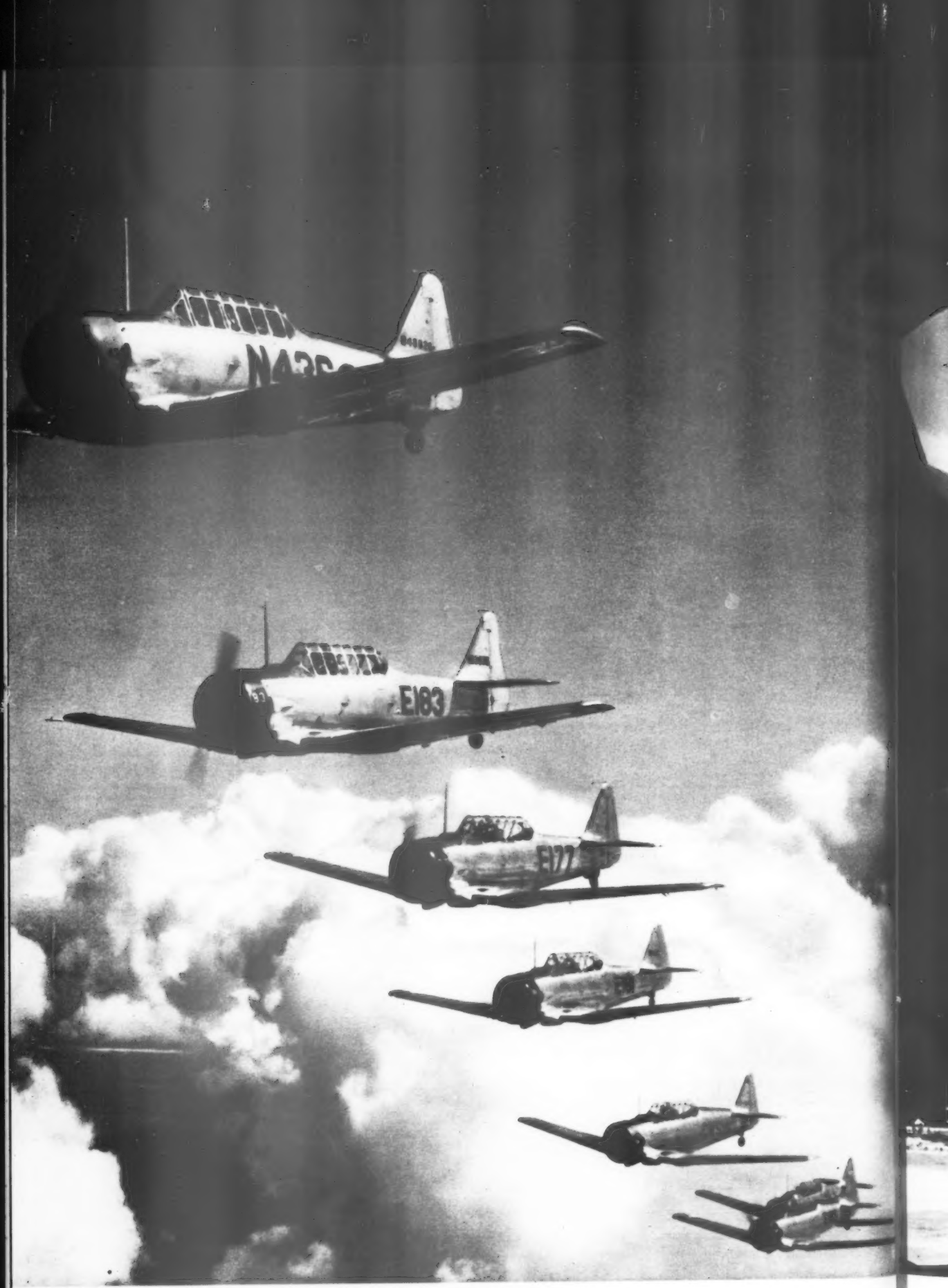
GUNNER

NIGHT LOADING

WHITE HOT

BRIEFING

LIBERATOR FORMATION



TRAINERS

BOMBER CREWMEN

PARATROOPER

LIMBERING MUSCLES

CROSS SECTION

CADETS

CLIPPED WING

RACKED WINGS

REFUELING

BOGGED DOWN

SPARE POWER

Backbone of the ATC is the Douglas DC-3, converted for cargo as the "Skytrain" and troop transport as the "Skytrooper."

AIR TRANSPORT COMMAND

Larger than the peacetime Army Air Corps, ATC blankets the globe, trains tomorrow's merchant air fleet for U. S.

MONTHS before victory in Africa, when Allied and Axis air power were nip and tuck from Algiers to Egypt, a big cargo plane of Air Transport Command was forced down on the desert 75 miles from Khartoum and radioed for help. Camouflaged pink-elephant style for desert operations, the plane eluded our searchers for hours but was finally spotted from the air.

Rescue planes prepared to do a "routine" job—parachute enough supplies to the stranded crew to hold them 24 hours until jeeps could roar across the sand dunes. Down dropped water, food and blankets, in the same manner that supplies have reached this war's stranded Americans from the Equator to points north of Greenland. The rescue party, circling overhead, prepared to speed back to Khartoum.

Suddenly the wind shifted and the chutes drifted away from the transport. An Arab appeared with two camels, gathered up the supplies as they landed and galloped off into the desert. The rescue planes had to repeat the whole performance, which went off without a hitch.

That, says the Army Air Forces Air Transport Command, is the sort of thing that makes "routine" a fighting word.

Despite lone Arabs, hurricanes, souvenir-hunters, sub-zero weather, snake-infested swamps and heat so intense that strong men faint, ATC gets on with the job. This job is to carry anything the War Department orders by air—anywhere.

Not yet three years old, ATC has developed into a gigantic network of air routes, communications, landing fields and supply depots stretched across six continents and four oceans.

Today, ATC, with thousands of pilots, is larger than the entire Army Air Corps of peacetime years. Before we had been at war 12 months, the command was flying more than 60,000 miles of routes, compared to a pre-war total of 41,000 miles for all U. S. domestic airlines. Midsummer totals were still upward.

War's necessities meant operations across the back fences of the world. Communication systems had to be set up where none existed. Weather stations had to be established at man's remotest outposts. Intermediate fueling stations appeared in the African jungle and "over the hump" on the air route from India to China—the lifeline which has replaced the Burma Road.

The command has two jobs: To deliver combat planes to the particular war theater where they are most needed by United States and Allied forces, and to supply these forces with vital war materials through a growing fleet of huge cargo planes.

The command's Ferrying Division picks up planes at the

Doing double duty, this ATC plane carries cargo lashed against one side, and pilots enroute to join their squadrons.

Engine parts and tires are unloaded at destination.

factory, sees that they are custom-tailored for the special demands of climate and terrain in their war theater, then flies them to the farthest battle fronts of the United Nations.

To do this on clockwork schedules, a vast reservoir of trained pilots and flight crews commute across the hemispheres. Most of these are Army men. Some are trained personnel employed by civil airlines under contract to ATC. Others are women.

The mainsprings of the ferrying division are eight major ferrying bases in the United States, located so that each serves a major aircraft manufacturing area. Through these bases flow in an increasing stream the 50 to 60 types of combat aircraft being produced in this country for ourselves and our Allies.

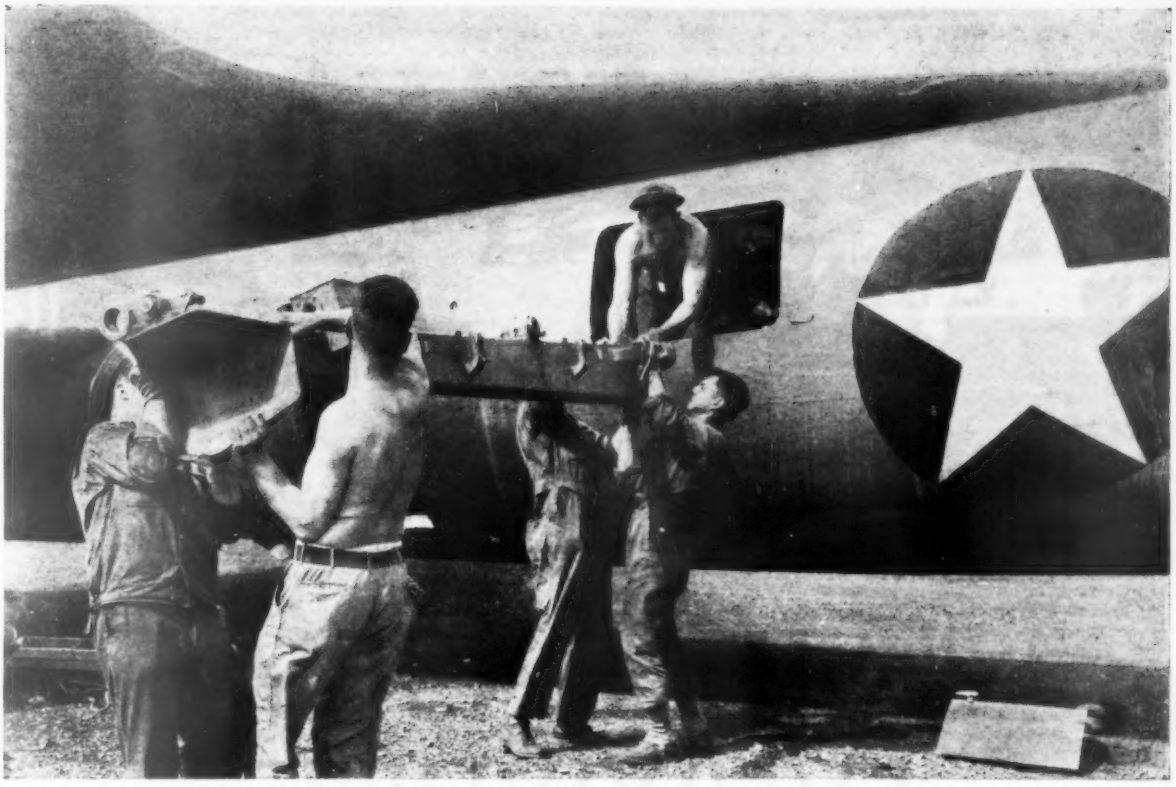
In order to obtain the necessary world-reservoir of trained personnel, the ferrying division organized its own pilot-training. These pilots begin on trainer planes, go on to combat craft, and finally are graduated to four-engined bomber schools. After this rigorous program, they gain experience as co-pilots on long-range, over-water flights under operating conditions, finally are made full-fledged first pilots on the big multi-engined bombers and cargo planes.

On the home front, many a ferrying job falls to the Women's Auxiliary Ferrying Squadron—the WAFS. Organized in September, 1942, by Pilot Nancy Harkness Love (who boasts more than 1,200 solo hours), the WAFS delivered their first plane exactly one month later.

The WAFS are doing a tough job well. They are flown daily to aircraft factories where they pick up a flight of planes and, with one of their number as navigator, fly in formation to delivery points all over the country.

The Command's second big job—that of keeping our aerial pipelines operating at maximum capacity—is handled by the Priorities and Traffic Division, which determines the relative importance of shipments. Priorities and Traffic asks: "Is this man, this cargo, this letter absolutely necessary to the war effort *now*?" No goods can be loaded, no passenger flown, until this question is answered.

Priorities and Traffic must decide on the contents of every cargo plane, must balance waiting backlogs of men and mail,



A "Flying Fortress" is pressed into service to transport a 105 mm. howitzer to a combat base in New Guinea.

must be sure no transport carries less than maximum load in *any* direction.

Since war-burdened shippers all want air transport, and only a fraction of the requests can be met at once, ATC has a responsibility of world significance. Its decisions on who and what can be carried, and *when*, can win or lose the war.

Behind many a victory are ATC's impartial, often ruthless, decisions. These are within the Army as well as outside. Priorities and Traffic must decide whether the supply needs of Signal Corps outweigh Ordnance at the moment, whether the Corps of Engineers, The Office of War Information or the Petroleum Administrator have top choice to send personnel to Africa next trip.

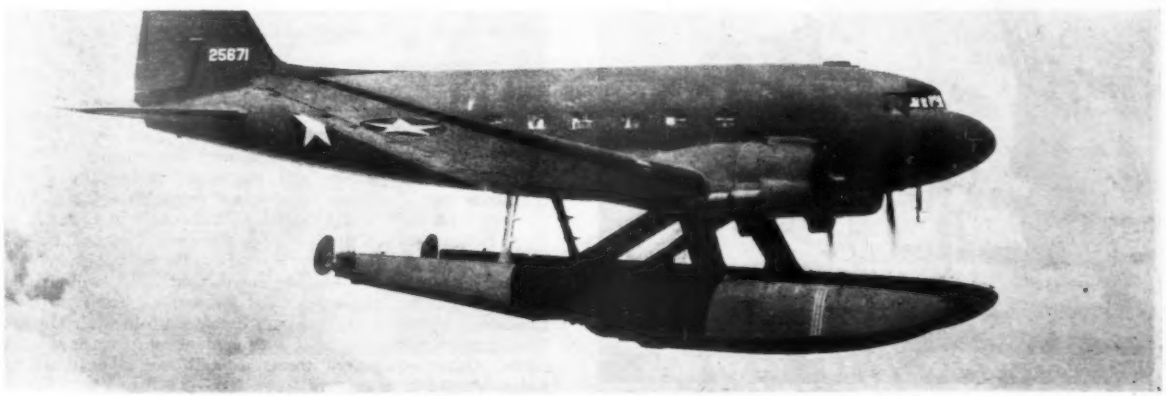
Some requests are met with laughter. One U. S. firm, for example, wanted to rush a Latin American lard manufacturer a sample tin can bearing an illustrated lithographed label of the company trademark, the Three Little Pigs. Next day came a priority request for shipment of ping pong and volley balls to a Government-administered conscientious objectors camp in Puerto Rico.

One man heatedly demanded air priority because he was "too fat to get into a Pullman upper berth." The wife of the vice president of a foreign country wanted to ship a bottle of hair tonic back home. A great department store was refused its request for a priority to ship an $85 negligee.

A Seattle girl wanted priority air transportation to Central America, where she was engaged to marry one of the inhabitants, on the grounds that her action would contribute to the "Good Neighbor" policy. A United States senator said he needed priority to be in good humor next day at voting time.

No joke to Priorities and Traffic was an insect threatening

(*Continued on page* 334)



Range of Douglas "Skytrain's" usefulness is vastly expanded as 41-foot floats convert it to amphibian.

Grumman "Wildcats" form background as Army airport engineers lay steel runway mats on Henderson Field, Guadalcanal.

AIR BASES— EVERYWHERE

Portable equipment such as this crane speeds construction of landing fields when runways are built of mat sections.

EVEN in a world surrounded by air war, it would make front-page news if some midwest town—say Wapakoneta, O., or Little Falls, Minn.—voted to pack up, furniture and all, and settle down in Australia's bush.

The courthouse would have to stay behind. So would the First National Bank, the lumber yard, the dry goods store and every house more solid than a tent. There'd be no morning paper, no milkman, no railroad train, no railroad. Merely getting food to eat, clothes to wear and tools to work with would be an endless headache to most of the citizens. Global pioneering is grim business.

Wapakoneta or Little Falls would probably give up the idea. The Army Air Forces *can't* give up the idea. With a war to win, the price of victory is uprooting enough men and equipment for a thousand towns like Wapakoneta and Little Falls, scattering the roots and planting them on a glacier, a piece of African veldt or a hot, oozing, unfriendly jungle clearing in New Guinea.

These battalions fly to distant fronts to build or repair airdromes. In global war an Air Force cannot have its engineers earth-bound. They must operate in island-to-island warfare or over mountains and deserts where air is the only medium of transportation fast enough for victory.

Even in spots where no man has penetrated before, aviation engineers use the finest equipment available. Large diesel tractors with bulldozer blades whine through dirt, stones and trees. Rollers harden the earth for runways. Carry-all scrapers move the earth. Graders level it. These battalions have electric generating plants for power and light, well drilling, pumping and filtering equipment for water. Their drills and explosives quarry rock, crushers break it up in the right sizes. Mixing machines combine it with cement and turn it into concrete. Other equipment treats asphalt and slaps down macadam runways.

Material alone will not build airdromes. Manpower—expert manpower—is required. Aviation engineer units include pre-

cision tool operators and carpenters, plumbers and electricians to build housing and base services. Engineers design the construction and surveyors lay it out.

All aviation engineers are combat soldiers. On the ground or in the air, they must be able to fight for what they build. They have—and use—heavy automatic guns against enemy air attack, light armored trucks and anti-tank guns. They have fought well in every theater. Their blood is spilled in the Philippines, in Africa, Alaska and South Pacific islands.

Not all overseas airdromes are built by aviation engineers. Need for bases is so great that other types of units, under the chief of engineers, have been given special equipment to help with the job. Thanks to them, many an outlying base and ferry route station is operating months ahead of schedule.

One combat engineer regiment carved a landing field from an atoll in mid-ocean. This volcanic island, not even a pinpoint on maps, had no water, no timber. Engineers had to transport everything they would need, then build their own docks to land it. But they erected fuel tanks, laid 1,500 feet of gasoline pipe line under water, installed water evaporation equipment, trained operators in its use—and finished the whole job in 100 days.

Aviation engineers built fields on Bataan from which the gallant fighters of General MacArthur's air force staved off Japs to the end. When our armies moved southward, their work was carried to Australia and New Guinea. Airdromes were built in Australia deserts and in the jungles behind Port Moresby.

The South Pacific islands are dotted with airdromes the engineers "raised from nature." One battalion built an airdrome used by Army and Navy planes in the Battle of the Coral Sea. These experts not only built the field—they unloaded aviation gasoline from tankers in the open water.

Hawaii's engineers opened a set of new fields almost before the fires of Pearl Harbor were out. These fields were built under pioneer conditions. Some crudely graded areas had only steel plank runways to speed the bombers' vengeance.

In Alaska, aviation engineers accompanied the Air Forces down the Aleutian chain. A steel runway secretly laid on one of these islands allowed fighters and bombers to protect Dutch Harbor and upset the Jap plans for their attack on that important base. When the Air Forces seized the Andreanofs to confront the Japs on Kiska and Attu, engineers wrested airfields from fog-bound rock.

In Panama, Puerto Rico and other Caribbean strongholds, Iceland and Greenland, in other hemisphere outposts, new bases stand as proof of air pioneering. Aviation engineers in England have multiplied the RAF's permanent airdromes for the bombardment of "Fortress Europe."

Airborne battalions of aviation engineers received their first test in North Africa. They were with Major General Doolittle in the first landings. They took part in the assault at Port Lyautey, helping to capture an airdrome. Here they assisted in filling the runway craters blasted by our own Navy flyers.

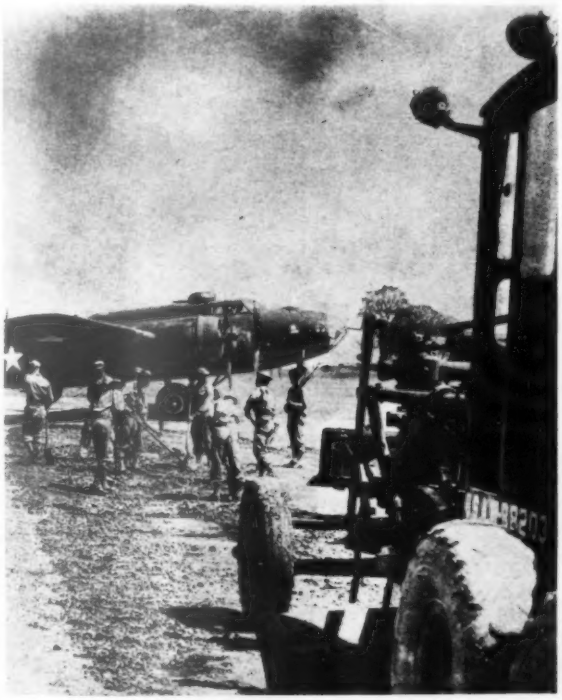
The AAF recently ordered two airdromes built fast on the Tunisian front. Fifty big transport planes flew the airborne aviation engineers a thousand miles east. Within three days after the arrival of the airborne engineers they had an airdrome ready for bomber operation. On the fourth day they finished a new airdrome for fighter planes.

Such airborne battalions are weapons of opportunity. Their light equipment and flexibility add speed to our forces against war's surprises.

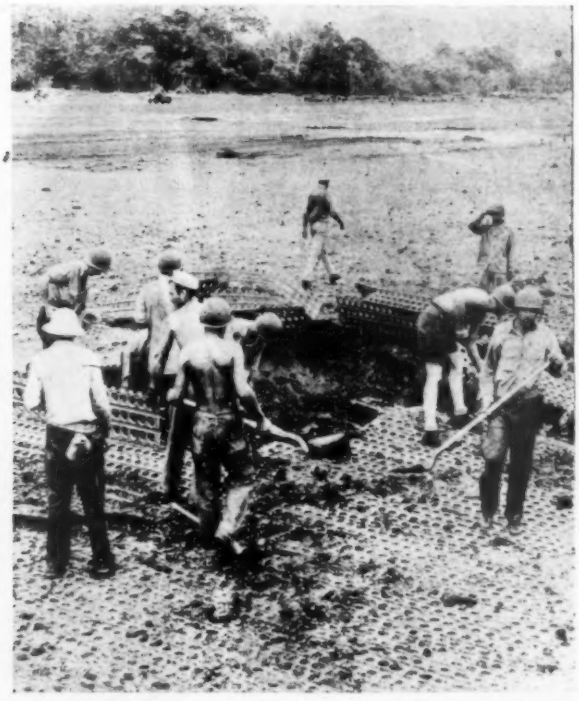
Wartime equivalent of the air base and its sub-depot is the

(*Continued on page 203*)

In constructing our gigantic chain of airports at home and abroad, Army engineers have surmounted every climatic and terrain obstacle in jungle, desert and in the Arctic.



"Fortress" makes first landing on Andrews Field, England, as engineers are completing the last stretch of grading.



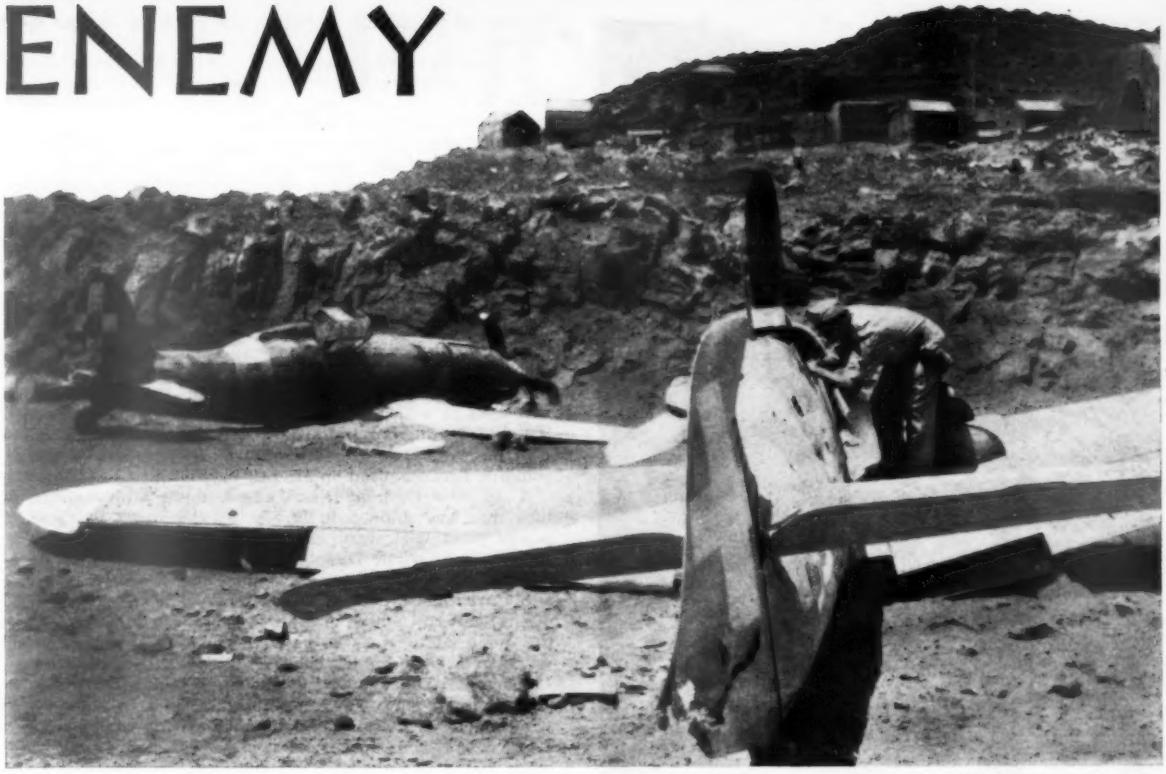
Use of cleated mats simplifies upkeep. When Japs bombed Guadalcanal runways (above) damage was quickly repaired.

WE STUDY THE

Analysis of Axis aircraft and equipment is the assignment of one whole AAF unit.

A Wright Field test pilot prepares to put a captured Messerschmitt Me-109F through a trial flight. Note similarity of nose cannon to Bell "Airacobra" design. AAF mechanics dismantled engine in 22 minutes, revealing how Germans had simplified its mounting.

ENEMY



Messerschmitt Me-109F bearing Italian insignia and Macchi 202 (left) are inspected after capture in Africa.

DAILY on the big platform at Station Supply, Wright Field, is unloaded a variety of shipments that have come thousands of miles from the combat zones—shipments that contain items of enemy equipment, from the smallest instrument that goes into a Jap or German fighter, to a complete airplane. Thus can the engineers at the Materiel Command study the fighting planes of our enemies.

Here at the receiving station for one of the strangest "businesses" of the whole war, we study what the enemy is doing, learn how to fight him better, and use his best ideas to our own advantage on our own fighting planes. Yes—we've learned some things from him.

All of this is part of the job of the Foreign Evaluations Unit, which comprises experts on foreign aircraft who report on the worth of the captured enemy equipment brought to the field for observation. During the past year equipment to arrive from the fronts included Me-109E and Me-109F Messerschmitts, a twin-engined Junkers Ju-88, and many pieces used in German aircraft—to say nothing of planes the Japs and Italians have unwillingly contributed.

AAF engineers have had a chance to study oxygen equipment. They have also carefully scrutinized other auxiliary parts of enemy aircraft such as guns, bombsights, radio installations, and clothing taken from captured flyers. What they have learned in most cases is that American aircraft and accessories are superior. But there are some exceptions.

One day a German Me-109F arrived intact and crated. Engineers told a group of mechanics who were inexperienced in foreign aircraft to take the engine out of the plane. Six mechanics did the work in less than 22 minutes—far less time than it would have taken to remove the engine from one of our own fighting ships with which they were familiar.

Close study revealed the Germans had ingeniously centralized their engine mounting so that all the fuel and control wires ran into a small number of main sockets. This made it possible to unplug the sockets quickly and dismount the engine. The results of that lesson are evident in the simplification of engine installation on our own planes.

Soon after that Me-109E was brought here, Army test pilots took it aloft for a series of extensive tests. This is the comment they made when they filed their reports: "Very easy to fly, with good stall characteristics, and handles well in the air"; "landings were easy and landing speeds are slower than for U. S. fighter types;" "this airplane would probably be at its best against fighters but would not do so well against bombers due to insufficient armor protection and lack of firepower."

These are actual statements taken from test pilots' reports. On the other hand, engineers who were not pilots carefully studied the plane for specific design features that we might adopt. They found two points of interest: "The pilot's safety belt was more comfortable and easier to adjust and handle than U. S. and British types, especially after getting wet;" "the location of propeller control on the throttle was more desirable." These recommendations have been noted and acted upon.

A Messerschmitt Me-109F which was captured in Russia came in knock-down form and has been in the process of assembly until quite recently. The engine is still running tests in the power plant laboratory.

When engineers studied the ship after it was assembled they reported that the cockpit was simple and the arrangement good, although "the lack of rudder pedal adjustment and the small size of the cockpit made it uncomfortable for a pilot of more than medium height."

Extensive tests are being run on this latest German fighter and reports will be filed with the engineering division for closer observation and action as soon as it gets into the air and has its flight tests completed.

Also under study by Materiel Command engineers are several British planes now at the field including a *Mosquito*, a *Spitfire*, a *Wellington*, a *Hurricane* and a *Horsa* glider. By comparison, the glider is larger than any in production in America today, although Materiel Command officers are now flight-testing something about equally capacious made by Waco. Now undergoing extensive flight tests is the *Mosquito*—which has attained in excess of 365 m.p.h. in speed tests.

While examining the *Wellington* bomber, engineers found that it was the only ship whose de-icing equipment would al-

Though an older German type, this Messerschmitt Me-110 was carefully inspected for possible production method changes.

Among engine types found in Italian planes was this seven-cylinder radial, similar to Wright "Cyclone" model of 1927.

low use of the balloon barrage cutting system adopted by the British.

It is not so much the airplanes that are now under observation as it is the small parts salvaged from wreckages of enemy ships in the combat zones and shipped to points where the evaluation experts can study them.

Among the most interesting of these items have been the German bombsights. These have already been tested extensively, and our engineers rate them inferior to the Norden sights. However, detailed reports indicate that the quality of the lenses going into the German sights is unexcelled.

German flyers in Africa carried with them large aluminum water containers, which were virtually thermos bottles. Engineers here were amazed to find the Germans using aluminum of the highest quality for this auxiliary equipment. This was taken to indicate that the Germans have plenty of the metal to put into their planes—even enough to use in auxiliary equipment.

From a downed German fighter came a Mauser Mg-51 20 mm. cannon, which armament engineers found will shoot from 800 to 900 rounds a minute—faster than most guns on our own aircraft. The gun is credited as being one of the outstanding firearms used on aircraft in this war.

A tall, thin German Diesel inline engine with opposed pistons that was shipped to Wright Field created a stir in the power plant laboratory. Engineers think the Germans may be trying to adopt Diesel engines in some of their newest fighter planes. In fact, one of the ships recently spotted by a *Spitfire* pilot flying at 46,000 feet—a record high for any of the German fighter aircraft—was reported to have one of the Jumo 207 engines as its power plant. The day the ship was first seen a *Spitfire* shot it down in a thrilling fight at 43,000 feet. The men at Wright Field believe that the "tall slim engine" may play an important part in some of the stratosphere efforts the Germans may attempt this year.

Power plant engineers have also been concerned with a large 1,600 h.p. German BMW-801 engine with a blower fan. The engine, an air-cooled radial which looks quite similar to American radials, has a unique cooling device—a large fan which blows cold air back on the engine and tends to keep it at correct operating temperature. This idea, rather well received by American engineers, has been tried out on a medium bomber.

In working on the German ships and other equipment at the field our experts have learned that the Germans ingeniously have written—in tiny print—over almost every vital construction part of their planes instructions as to how the particular piece is put together and how it is repaired. This, it is asserted, tells the whole story of the carefully prepared German plan. It made it simple for fifth-columnists in the Lowlands and other conquered countries to turn "mechanic" and help grounded pilots. In some cases similar helpful ideas are being adopted on our new fighting planes, although we have made our own modifications.

German aircraft are extremely easy to maintain and are compact. For example, the engine mounting of the Me-109F is made of magnesium alloy and has a simplified construction of semi-cantilever design. The engine on the Focke-Wulf FW-190 is also carried in a compact arrangement compared with some engines in German and American aircraft. Magnesium alloys are used extensively all through the German airplane, creating the conclusion that there must be a good supply of the metal available.

At present there are no Japanese fighters or bombers at the Materiel Command's test center. These have been tested elsewhere. However, various types of Japanese equipment are under close observation. There are, for instance, several types of Japanese machine guns. One 7.9 mm. gun is of poor design, being an almost exact copy of the British guns used in 1914. In tests against our ¼-inch armor plate it hardly dented the metal, and this is comparatively thin plating by contrast with the heavy metal armor going into our aircraft today.

The Japanese do have, however, an effective 20 mm. cannon. The one tested was from a Zero. Tests conclusively prove prove, however, that it is inferior both in rate of fire and velocity to the .50 caliber guns that are going into our fighters and bombers.

Various radio equipment taken from both German and Japa-

(*Continued on page 284*)

PHOTO RECONNAISSANCE

"BETTER photography creates better bombing" is an obvious truth to Air Force commanders in all active theaters. They believe in photography as they believe in firepower, for combat experience has shown that more than 80 per cent of military intelligence is either obtained or verified by aerial photographic reconnaissance.

Effective use of air power depends upon the ability of reconnaissance to locate prime targets. Combat proved at the outset that the surest way to reduce an Air Force to impotence was to waste its power against inadequate targets. On the other hand, devastating effect was achieved when the total resources of planes and crews, fuel and ammunition were hurled against a target of maximum opportunity.

Such targets are not located by chance. They result in large measure, from ceaseless aerial photographic reconnaissance. Day and night, camera planes probe deep into the enemy's territory to record his movements and unmask his plans.

Modern aerial technique demands an exact knowledge of targets, for the best way bomber crews can be satisfactorily briefed before a mission, is to show them a picture of what they are going to hit.

Bombers do not leave the ground unless photographs prove the value of the mission.

From each theater comes the cry for "more pictures." In combat operations, 100 prints may be distributed from each negative. The Air Force commander and his staff, the Navy, ground forces and Allied airmen clutch at every scrap of photographic information.

Photographic planes streaking over bombed cities after a mission bring back exact answers to a commander's questions. What factories have been struck? What storage dumps remain intact? How long will railroad yards and switching points be bottlenecked?

Camouflage is seldom effective. Modern photographic methods detect it instantly.

Daily sorties over the Channel ports told the British the exact status of Hitler's invasion plans. They merely counted the landing barges and when the prize looked worthwhile, they bombed them into splinters.

Following a practice copied from the British, fighters with cameras come in at low altitude, get their pictures and return quickly to base.

Recently, after a test at Wright Field, a photograph taken from a Lockheed *Lightning* going faster than 300 m.p.h., as low as 300 feet, was so sharp that engineers could count the telephone wires which the plane had flown over.

Tests have been conducted with a "strip film" camera which makes a continuous picture on roll film.

Cameras are indispensable in searching out weak spots in our aircraft through recording take-off and landing characteristics, recording instrument dial readings during test maneuvers, training pilots and testing various types of materials.

Typical of photography's woes and triumphs in wartime is the story of one photo squadron. In April, 1942, nine officers and 60 men disembarked in Australia with four *Lightnings* modified for photographic use. Nine days later the squadron commander flew the first mission over Rabaul.

Mechanics, many of whom had never seen a *Lightning* before, had assembled the aircraft. They lacked both technical orders and instruction manuals. Undaunted, the pilots and mechanics persisted until their four airplanes were ready for the journey to North Australia. Two ships forced down en route required further repairs.

Yet continuous reconnaissance was maintained over Lae,

(*Continued on page* 340)

Without aerial photography bombing would be guesswork, its results unknown.

Still widely used is this hand-operated oblique camera, although trend is toward the fixed, automatic type.

Latest forecasts are studied by AAF pilots prior to each mission. Pilot at left points to cold front whorls on weather map.

WEATHER GOES TO WAR

The Weather Wing of Flight Control Command strives ceaselessly to take military advantage of climatic conditions.

FROM sun and wind and rain and gloom of night, the Army Air Forces has recruited a potent ally.

Weather, that reprobate which we blandly ignore when it behaves itself, always has been global. It moves with the speed of lightning and hurricanes, too swift for men on the ground. Only air power could match its pace.

The Air Forces, seizing upon every weapon, has come to terms with weather, studied its moods, charted its fevers, treated it with respect—and gained an ally.

Weather's importance to all military operations is recorded daily in communiques and news accounts from every battlefield. In the Solomons, rainfall is reckoned as carefully as opposition strength. In Africa and the Middle East, sand storms are a heavy factor. Aleutian operations demand disposition of the problem of fog.

That we may keep weather our ally, the Weather Wing of Flight Control Command performs constant research, training and operations.

Even ground war is not fought on the smooth surface of maps nor in their world of neat lines and gigantic panorama. It is fought in the real world of smoke and dust, wind, heat and cold, or rain, ice and fog, just as it is made up of rocks and hills, rivers and oceans.

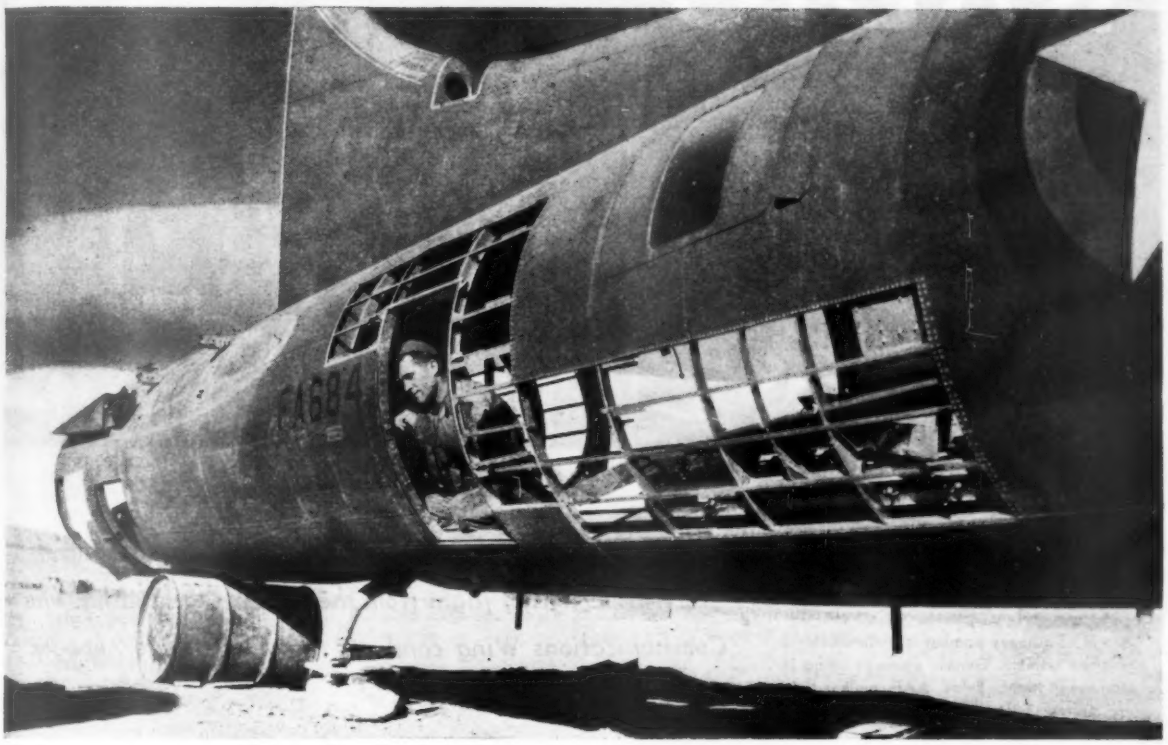
Any change in weather which disorganizes communications favors sudden attack, but the attacker must be resourceful, must know what the weather will be and how it will affect operations.

Weather is vitally important to the Air Forces, since the air is its medium. Not only are there weather hazards to be avoided or minimized, but there are opportunities to be seized. Attacking aircraft such as bombers or ground support planes often use clouds for concealment. Yet cloud layers may be a dead giveaway by silhouetting the planes against a light background. Fighter pilots prefer clear skies or scattered clouds to stalk their prey.

(*Continued on page 272*)

The radio observation unit reaches stratosphere before balloon bursts. The broadcasting set then 'chutes down.

FIELD MAINTENANCE



Wrecked planes, such as this "Flying Fortress," provide a source of replacement parts for other craft.

THIS is the story of a fighter plane named "Yank."

"Yank" is a responsibility, a worry and a care, yet a source of pride to a group of men in a gray concrete building near Fairfield, O. They are the topflight AAF officers and civilian experts at Patterson Field, headquarters of the Air Service Command.

On the day "Yank" joins a combat squadron, it becomes a ward of Air Service Command. From that moment "Yank" is a deadly weapon, a challenge to its sweating mechs, a vital statistic in the files of the gray concrete headquarters at Patterson.

So that "Yank" and more than 70,000 of his brothers may fly and fight and win, 600,000 people, three-fifths of them civilians, toil overtime.

From less than 500 peacetime employees of the Field Service Section of the AAF Engineering Division (the parent organization), Air Service Command has grown to world proportions. Its annual dollar volume is greater than that of General Motors Corporation. Its directing heads include hundreds of business and industrial specialists, military and civilian, all joined in a prime Air Forces task.

"Yank", like the others, must be serviced and repaired regularly, get more guns if need warrants, perhaps undergo a major operation—a new engine, a revamped wing. The fighter's own crew makes the first check-up after it takes to the air. This is the 25-hour inspection, an added precaution to normal pre-flight and daily inspections.

During the 25-hour inspection, which may be performed over a 10-day period without halting "Yank's" daily operations, the crew inspect and adjust just about everything important in the airplane—propeller and accessories, power plant, cooling equipment, engine controls, fuel system, carburetor, hand pump, oil lines and cooler, spark plugs, magneto, battery, landing gear, wheels and brakes, hydraulic system, fixed surfaces, fuselage,

(*Continued on page* 320)

The Air Service Command has become a world-wide organization of highly skilled technicians, able to work under any hazard.

Field maintenance men use regular equipment, when available, or can improvise when away from bases.

RADIO

Artery of a heavy bomber is its intercommunication system. Gunner above is being instructed in flight. Below, AAF command sets are tested before installation in aircraft.

Nerve system of modern aerial warfare, radio controls every movement of flight from the take-off to landing. The Communications Wing conducts the AAF's huge network.

HIGH up the craggy side of a Tunisian mountain, eight men of the Army Air Forces helped win victory in Africa by just sitting tight.

They never dropped a bomb.

They took no shots at the Focke-Wulf overhead nor the Nazi troopers below. Physically, they were so far out of the war they spent hours teaching two Arab kids to sing "Deep in the Heart of Texas." The eight did nothing, in fact, but fiddle with the radio dials. Yet, few jobs did more to speed the Axis defeat on Cape Bon.

These Air Forces men ran a portable radio station that brought our pilots home. Unshaven, isolated, feeding on rations that arrived once a week, the eight radiomen directed Allied flyers to a friendly airdrome. Many a pilot headed in from the Mediterranean in a bad way, his ship riddled with bullets, often low on gas. Members of his crew might be wounded. These planes and men got back only because of the eight who guarded the airways. They waited, listened and broadcast landing directions.

This, of course, was a small unit in the world's largest aviation radio network—the Communications Wing of the AAF's Flight Control Command—which engages nearly 375,000 men.

Transmission of military orders and information, and the use of highly secret electronic devices, have introduced a new development in warfare. Radio co-ordinates the striking power of our Air Forces, Naval forces, and ground forces with each other and with our Allies.

In 1942, more than $600,000,000 worth of radio equipment was purchased for the Air Forces, and more than $1,800,000,000 worth of equipment is scheduled for delivery in 1943. As much as $44,000 worth of radio equipment is frequently installed in one Boeing *Flying Fortress*. These figures give some hint of the role communications plays in aerial warfare.

Without adequate radio contacts, air units cannot be properly controlled, and they lose a large part of their combat efficiency. Planes would be scattered all over the map. Fighters would go haphazardly aloft, hoping to find someone to fight, perhaps missing out on their missions of interception and destruction

of enemy raiders. Bombers would have to operate on their own, attacking such casual targets as the eye beheld.

To control bombing and fighter missions, the AAF must have communications between planes, and between planes and ground. In air transport and ferrying operations, AAF planes gird the earth. These planes, flying between control points, operate on radio ranges and utilize communications facilities maintained and manned by Air Force personnel. On all overseas flights, transport planes are constantly under control by radio communications.

At Wright Field, Dayton, O., an Aircraft Radio Laboratory handles all research and development, procurement, inspection, storage and issuance of aircraft radio and ground radio used for navigational purposes.

As Army airplanes are operated in all parts of the world, from pole to equator, rigid tests must make certain that radio equipment will function at every altitude, in all temperatures and climates. Flight tests determine the performance of equipment in the air, also find any "bugs" which may develop. AAF standards require that equipment perform at extreme temperatures, high altitudes and 90 per cent humidity. There are electrical and mechanical tests as well.

Latest radio secret of which the public has a glimmering is radar—radio detecting and range—which sends out radio rays that are beamed and bounced back from any object in its path, thus detecting obstructions and friendly and enemy aircraft.

It is one of the marvels made possible by the electron tube. Ultra high-frequency waves travelling with the speed of light can be focused, scan the air and sea. When they strike an enemy ship or airplane, they bounce back. Radio waves travel at a constant speed of 186,000 miles per second. Thus a small space of time is required for such signals to travel to a reflecting surface and return to a receiver, so that, with means provided for measuring this time interval, it is possible to determine the distance to a given target. Radars operate through fog, storms, and darkness, as well as through cloudless skies They are, therefore, superior to both telescopes and acoustic listening devices.

Radar is used for both defense and offense. In fact, the British, who call their similar apparatus the radio locator, say it was instrumental in saving England during the aerial blitz of 1940 and 1941. At that time the locators spotted German raiders long before they reached a target area and thus gave the RAF and ground defenses time for preparation. Since then radar has stood guard at many danger points along United Nations frontiers and at sea, warning of the coming of aerial and sea-borne enemy forces, and contributing towards victory in combat.

It was first discovered in the United States in 1922, when scientists observed that reception from a radio station was interfered with by an object moving in the path of the signals. Accordingly, a radio receiver was set up on the banks of a river and the effects of signal reception caused by boats passing up and down the river were studied. The experiment of installing the receiver in a truck was also tried, and it was observed that similar disturbances were produced in the receiver when the truck moved past large buildings. Development work was immediately undertaken so that the new discovery might be used for detecting vessels passing between harbor entrances, or between ships at sea.

So far, it had been necessary to have the moving object pass *between* the radio transmitter and the receiver. This obviously limited the possible fields of application. In 1925, it was found that the surface of an object, or target, would act as a reflector of high frequency radio waves. In other words, the radio signals sent out by a transmitter could be made to strike a target, and then "bounce" back to a receiver. This made it possible to have both the transmitter and the receiver at the same location.

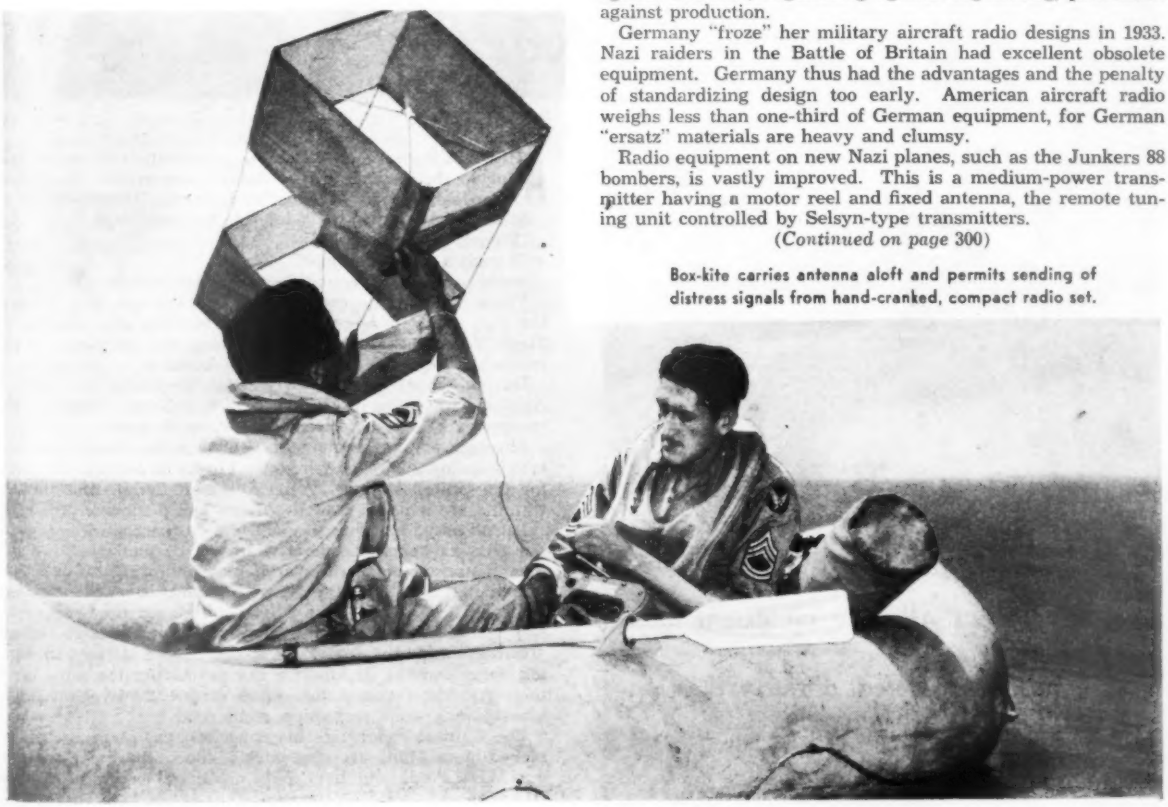
By 1930, research engineers were able to pick up reflected signals from planes passing overhead. By 1934, they had developed a satisfactory means of measuring the distance between the radar transmitter and the target. Since then other advances in the field have been made, some of which, after the war is over, will undoubtedly contribute to the security and comfort of a world at peace.

German signal equipment is good and is being produced in large quantities. But we believe we are one step ahead of the enemy, and we intend to increase this lead. Research is pitted against research, engineering against engineering, production against production.

Germany "froze" her military aircraft radio designs in 1933. Nazi raiders in the Battle of Britain had excellent obsolete equipment. Germany thus had the advantages and the penalty of standardizing design too early. American aircraft radio weighs less than one-third of German equipment, for German "ersatz" materials are heavy and clumsy.

Radio equipment on new Nazi planes, such as the Junkers 88 bombers, is vastly improved. This is a medium-power transmitter having a motor reel and fixed antenna, the remote tuning unit controlled by Selsyn-type transmitters.

(*Continued on page* 300)



Box-kite carries antenna aloft and permits sending of distress signals from hand-cranked, compact radio set.

FOREIGN TRAINEES

Chinese students cluster about cockpit of Curtiss "Warhawk" as their instructor explains grouping of instruments. Many Chinese cadets already had seen combat.

☆

Army Air Forces' training facilities are being shared with our Allies to an extent that will greatly hasten the defeat of the Axis in the air.

☆

ARIZONA'S afternoon sun broils a formation of cadets drilling to the cadence of the Army's memorable "hup-hoot—heet-foah!" A shrill whistle—a shout—"Dismissed!"

Sunburned youths streak for the post exchange.

"Please, a meelk shek!"

"I want a choclat sundae!"

Nothing unusual about this, except for one thing.

These are Chinese cadets. Four months ago they were on the high seas. Six months ago many of them were fighting the Japs. Now they are in flying training for the blue-and-gold wings of China, the silver wings of America.

During recent months there have been Chinese cadets in Arizona, Yugoslavs in Florida, British in Texas, Dutch in Mississippi and Latin Americans from coast to coast.

Through arrangements with Allied governments and governments-in-exile, the Army Air Forces is forging air power for the United Nations. Americans and their Allies in flight training are a preview of the flying world victory will bring.

It isn't easy. It requires much tact on the part of everybody —a give-and-take attitude that airmen particularly must possess. Historians of World War II may well find this AAF-patterned flight training the "extra weapon" we need to defeat the enemy. Who are these Allies—where did they come from, how well do they fly, how do they raise our sights on victory?

Chinese and other nationals of the United Nations undergoing flying training in America live practically the same life as their American classmates—same drill, same type of rooms, same planes, same recreation, same food.

The Chinese cadet, like his American prototype, is a hand-picked man. Many are graduates of the Chinese equivalent of our West Point and have held commissions in the Chinese

Chinese students prove excellent pilot material. Eager to get into combat, they quickly adapt themselves to U. S. training.

Army. They are training in America because they would rather do one thing more than anything else in the world: fly a plane in combat against the Japs.

They follow orders to the letter. For example, one ground school instructor requested Chinese cadets to fill out a personal history questionnaire. He produced a sample copy of the form and demonstrated how to fill it out, using the name of John Smith. The Chinese nodded, and hurried to comply. When the instructor had collected the papers he found that the visitors had all inserted the name John Smith—had merely copied his sample exactly.

In China the air force is a separate branch of service. As flying cadets, these officers received their pre-flight and primary flight training in China. After their school was bombed three times, the Chinese government arranged for U. S. training, which started them from scratch.

The Chinese government furnishes all clothing and pays the salaries of the Chinese detachment. Their training is financed by the United States and is charged against the Lend-Lease program.

The advanced groups are divided into pre-fighter and pre-bomber squadrons. The pre-bomber group has been given transitional training in strategic bombing.

The larger the formation, the better Chinese cadets like it. "Lots of airplanes make very pretty sight," they exclaim.

That expression is a slant on their future, something to blot out memories of cowering against wrecked buildings while overhead droned "lots of airplanes"—all Japanese.

Practically all of the earlier cadets now are flying and fighting for China, rated as pilots and commissioned officers in the Chinese Air Force. Their places here have been taken by new men.

The greatest obstacle a Chinese cadet has to hurdle is the English language. First he must learn 800 basic words, then master a technical vocabulary of aviation terms—and slang. But this language problem works both ways.

When an instructor and his student are coming in for a landing, for instance, and the student is leveling off too high, the instructor may say "Kai yu-ma"—Chinese for "give 'er the gun!"

One night a formation of Chinese cadets were on a cross-country flight from their Arizona base. Fascinated by their radio equipment they talked at length, plane to plane. A radio operator in California, hearing this strange chattering on the airlanes, thought Japs were flying over. It took hurried radio signals—in English—to calm him.

The AAF makes every effort to ease the strain of teaching in a new language. Civilian Chinese were hired as interpreters. Hand signals are developed to a fine point. All loudspeaker orders and blackboard instructions are given in both English and Chinese.

Sign language fills many a gap, and naturally. Flying instructors always have used their hands to illustrate banks, turns, dives, climbs and stalls. They found the Chinese no slower than we to recognize such signals.

Meanwhile instructors were picking up Chinese, too. "Yo fay" meant to the student "I have it," when the instructor took the controls. "Ni fay" meant "you have it—you fly the ship."

To rouse attention, instructors use one word: "Nippon!"

Flight instructors at a Texas field allowed students to use Chinese characters on their flight plans and data sheets, thus overcoming the Chinese inability to express themselves clearly in English. These characters then are translated and graded.

(*Continued on page 338*)

Dutch cadets at Royal Netherlands Military Flying School at Jackson, Miss., under supervision of AAF Training Command.

INSTRUMENTS

A complicated maze of mechanical devices is the modern plane's nerve system.

THERE could be no air war without aircraft instruments. Actual logs show that navigation instruments alone are vital to 90 per cent of all missions flown by the Army Air Forces. Indeed, without instruments modern aircraft would never get off the ground.

Today's speeds, distances, temperatures and movements in aircraft generally outrange human senses. Before a pilot starts any mission he must know scores of things about his airplane. He can't put his finger on a cylinder head to see if it's warm enough. He can't count the revolutions of his propeller. Instruments tell him these things and many more.

Instruments have been devised to bridge the gaps between modern aircraft performances and the human senses that must control them.

At the outset they were primitive. Pilots in World War I felt luxurious if they could add an oil temperature gauge to a compass, a tachometer and an altimeter. The Dayton establishments of the Army Air Forces and its forerunners are largely responsible for the scores of instruments in a modern fighter or bomber.

The developments began with the Engineering Division of the Signal Corps Aviation Section at old McCook Field. As airplanes and engines and radio developed, pioneer airmen studied the problem of safe and efficient flight. Original research was undertaken. Ideas from private manufacturers were welcomed, tested and applied. And as more was learned through instruments about each succeeding type of equipment, better equipment was devised and better instruments developed to measure performance.

The great developments have been made during the lifetime of men and women still working there. Engineers at Dayton developed the earth inductor compass, the sextant and the gyro compass, and applied them to aircraft. They made the first completely blind instrument landings. They were the first to fly without touching hands to the controls—automatic flight that included landings and take-offs. They have been indirectly responsible for development of the most carefully guarded instrument of this war, the precision bombsight.

With all the precision of a watchmaker, this AAF technician is checking an instrument's inner gear.

AAF instrument men are experts in their field, as is this specialist shown operating a magneto tester.

Instruments of today's combat plane fall into four categories: (1) flight instruments, (2) navigation instruments, (3) engine instruments, and (4) training instruments.

Principal among the flight instruments are the air speed indicator, the rate of climb indicator, the turn and bank indicator, the flight indicator (artificial horizon) and the directional gyro. These tell the pilot the position of his airplane with relation to its own axes, the speed at which it is moving through the air, how fast it is climbing. They supplement the pilot's own eyes, fallible at modern speeds and distances.

The automatic pilot, sometimes included in this group, coordinates the plane's flight with data furnished by other instruments. It has sometimes been called a luxury: It allows the pilot and co-pilot to rest! Yet without that rest during the long interval between take-off and target on missions of hundreds of miles, pilots and co-pilots would be able to fly only two missions a week. Without the automatic pilot we would simply not have enough men to carry our part of the round-the-clock bombing of Hitler's Fortress Europe.

Research resulted recently in one further step to relieve the human pilot. It is now possible for him to select a magnetic bearing or a radio compass heading trained on some radio station either ahead of or behind the airplane.

The extraordinary strains of wartime operations emphasize the engine group of instruments. At extreme long range our bombers are carrying loads that would surprise their designers.

Instruments must tell the engine's story from moment to moment, as it speeds up to avoid bad weather or as it slows down to keep its rendezvous on schedule time—and, most critical of all, when the bulk of the load—its bombs—is suddenly discharged over the target. Some of the instruments used are cylinder head temperature gauges, oil gauges, coolant gauges and pressure gauges for vacuum, fuel and manifold; tachometers, fuel mixture indicators and exhaust gas analyzers.

Materiel Command at Wright Field is now meeting another

(*Continued on page* 345)

Octo

EYES UPSTAIRS!

On many fighting fronts of the world, our tank-destroyers often count on the Piper L-4 "Grasshopper" to help spot enemy tanks. Serving as the "Eyes Upstairs," the Piper L-4 flashes instructions by radio to the tank destroyers, directing their courses and fire.

The plane's ability to fly low, land quickly almost anywhere and hide easily enables it to play an important part also in the Artillery, Cavalry and Infantry. It acts as a scout, directs troop movements, transports officer personnel and delivers messages.

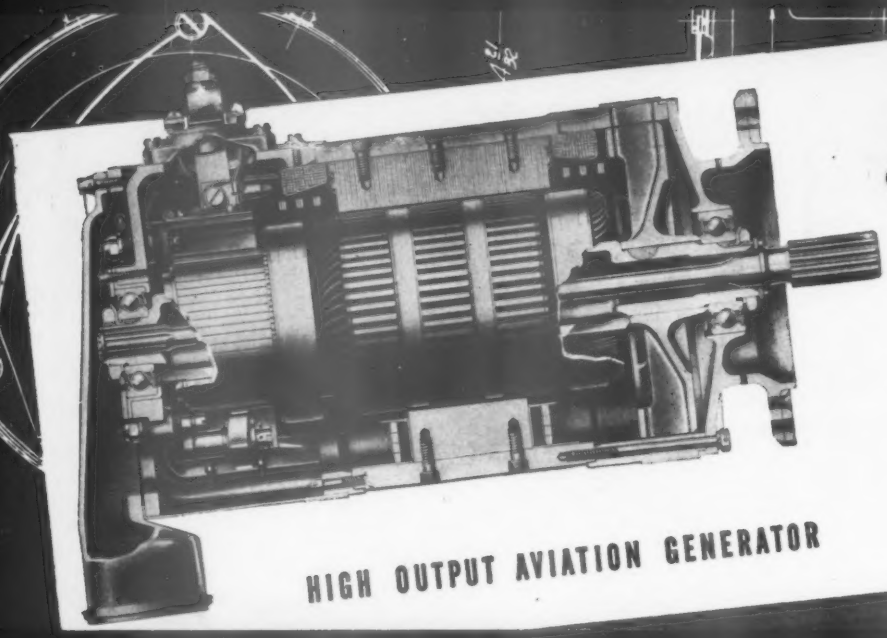
The advantages of the Piper L-4 in wartime will prove invaluable also in peacetime. Then, in your smart, new Piper Cub you'll hop around the country on vacation and business trips with the greatest of ease, pleasure, safety and economy.

FREE BOOKLET ON HOW TO FLY. Send today for your copy of "You, Too, Can Fly!" If you also want the full-color Piper catalog, enclose 10c in stamps or coin for postage-handling. Piper Aircraft Corporation, Dept. PA103, Lock Haven, Penna.

16mm. SOUND FILM—"The Construction of a Light Airplane." For distribution points write: Supervisor, Audio-Visual Aids, Extension Services, Penna. State College, State College, Penna.

PIPER *Cub*

Points the Way to Wings for All Americans



HIGH OUTPUT AVIATION GENERATOR

Eclipse* Type 914 Aviation Generator. Designed to convert high speed mechanical energy into electrical power for battery charging and other requirements. Integral fan and blast cooled, interpole and compensating coils, and pencil type drive shaft assure dependable performance at rated speeds.

DEPENDABLE POWER... P

DESIGN CHECK CHART, ECLIPSE TYPE P-2 GENERATOR

Application

✔ For application as an electrical power supply source to aviation engines incorporating a 3 to 1 generator drive ratio and with provisions for air blast cooling.

✔ For application as an electrical power supply source to auxiliary engines incorporating a 6,000 RPM generator drive speed. No provisions for air blast cooling necessary.

Performance

✔ For main engine applications with provisions for blast cooling, continuous full load rating 200 amperes, 28.5 volts, at 5,000 to 10,000 RPM. Permissible intermittent overload 300 amperes, 28.5 volts.

✔ For main engine applications wherein aircraft is operating at low cruising speeds, generator will provide three-quarters output or 150 amperes, 28.5 volts at 4,400 RPM.

✔ For auxiliary engine application without provisions for blast cooling, continuous full load rating 200 amperes, 28.5 volts at 6,000 RPM.

Design

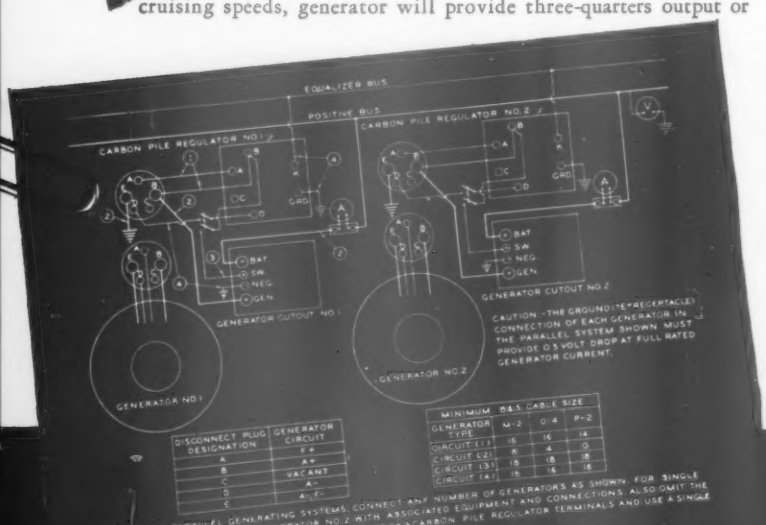
✔ Designed for increased strength, generator incorporates a steel mounting head and a floating type flexible torque drive shaft which absorbs engine torsional vibration and compensates for any slight possible drive misalignment.

✔ On main engine applications, air blast cooling, internal cooling fan and hollow armature shaft assure full load at minimum temperatures. For auxiliary engine application, internal fan provides adequate cooling.

✔ Improved generator terminal design, with brush rigging freely accessible for brush replacement and adjustment of spring tension, plus improved brush material for high altitude operation, assure dependable operation and long service life.

✔ Fixed brush positions requiring no adjustment plus inclusion of interpoles and compensating windings permit improved commutation and increased overall generator efficiency.

✔ Compactly designed, weight only 36.6 lbs., overall dimensions are 12 5/32" long by 6" in diameter.


EQUALIZER BUS
POSITIVE BUS
CARBON PILE REGULATOR NO. 1
CARBON PILE REGULATOR NO. 2
BAT
SW.
NEG.
GEN
GENERATOR CUTOUT NO. 1
GENERATOR CUTOUT NO. 2
GENERATOR NO. 1
GENERATOR NO. 2
CAUTION - THE GROUND (TO RECEPTACLE) CONNECTION OF EACH GENERATOR IN THE PARALLEL SYSTEM SHOWN MUST PROVIDE 0.5 VOLT DROP AT FULL RATED GENERATOR CURRENT.

DISCONNECT PLUG DESIGNATION	GENERATOR CIRCUIT
A	F+
B	A+
C	VACANT
D	A-
E	A-, F-

MINIMUM B&S CABLE SIZE			
GENERATOR TYPE	N-2	P-4	P-2
CIRCUIT (1)	16	16	14
CIRCUIT (2)	8	4	0
CIRCUIT (3)	18	18	18
CIRCUIT (4)	16	16	16

NOTE - FOR PARALLEL GENERATING SYSTEMS, CONNECT ANY NUMBER OF GENERATORS AS SHOWN. FOR SINGLE GENERATOR SYSTEMS, OMIT GENERATOR NO. 2 WITH ASSOCIATED EQUIPMENT AND CONNECTIONS. ALSO OMIT THE EQUALIZER BUS AND CONNECTIONS TO TAB "D" AND TAB "A" CARBON PILE REGULATOR TERMINALS AND USE A SINGLE POLE, SINGLE THROW LINE SWITCH.

*TRADE MARK OF BENDIX AVIATION CORPORATION

Eclipse

ECLIPSE-PIONEER DIVISION

CARBON PILE VOLTAGE REGULATOR

Eclipse Type 1042 Carbon Pile Voltage Regulator provides a compact, light-weight voltage control for either single or parallel generating systems. Mountable in any position, these precision built units assure precision control of aircraft power supply systems.

PRECISION CONTROLLED

DESIGN CHECK CHART, ECLIPSE TYPE 1042 CARBON PILE VOLTAGE REGULATOR

Application

✔ For application to 24-volt aircraft electrical systems to regulate the voltage of single or parallel operated engine driven D.C. generators to a constant and predetermined value at varying speeds and load requirements.

Performance

✔ Regulates voltage of generators in 24-volt systems within plus or minus 2% of setting, where maximum power dissipation does not exceed 100 watts under blast cooling operation, or 75 watts without blast cooling.

✔ Adjustable to maintain between 26 to 30 volts over a resistance range of .7 to 55 ohms. In parallel systems regulator will divide full load current within plus or minus 5%.

Design

✔ Automatically controls generator field current by continuously varying resistance of field.

✔ Pressure, controlled by a solenoid coil connected across output, is exerted on a stack of carbon discs, thereby varying carbon pile resistance, and providing even, continuous regulation without lag or fluctuation.

✔ Produces a minimum of radio interference due to absence of regulator contacts of the vibrating type.

✔ Designed for plug-in connection to standard base, facilitating installation and removal. To compensate for voltage line drop and facilitate paralleling generators, a rheostat is provided for adjustment purposes.

✔ Compensating windings insure equal division of load to each generator in parallel operated systems. Finned regulator housing provides for rapid heat dissipation.

✔ Compact and weighing only two point six (2.6) pounds, the overall dimensions are 4 9/16" long, 4 1/16" wide and 3 7/8" high.

SPECIFICATIONS

Eclipse Engine Driven Single Voltage Battery Charging Generators and Carbon Pile Voltage Regulators

MILITARY TYPE	ECLIPSE TYPE	NOMENCLATURE	VOLTS	AMPS	SPEED RPM	SHIELDING	COOLING	WEIGHT
	1235-1	Generator	28.5	15	2,500 to 4,500	1¼in.-18 Single Spout	Blast	15.5
	1202-1	Carbon Pile Voltage Regulator	28.5		For use in conjunction with Eclipse Type 1235-1 Generator			2.5
M-2	1381-3	Generator	28.5	50	2,500 to 4,500	AN-3102-22-12P	Fan	24.9
M-3	1381-1	Generator	28.5	50	2,500 to 4,500	AN-3102-22-12P	Fan	24
N-75-25B	1273-1	Generator	30	75	2,000 to 4,000	1¼in.-18 with 1¼in.-18 adapter	Blast	31.6
N-75-2RA	1298-1	Generator	30	75	4,000 to 8,000	1¼in.-18 with 1¼in.-18 adapter	Fan & Blast	23.5
	1305-1	Carbon Pile Voltage Regulator Control Box	28.5		For use with 4.75 Generators. Consists of Voltage Regulator assembled to Control Box Base			4.7
O-2	907-1	Generator	28.5	100	5,000 to 10,000		Fan & Blast	26.0
O-4	907-5	Generator	28.5	100	5,000 to 10,000		Fan & Blast	26.0
P-2	914-3	Generator	28.5	200	5,000 to 10,000		Fan & Blast	26.0
Slow Speed P-2	1193-1	Generator	28.5	200	3,250 to 8,000		Blast	44.0
	1042-2	Carbon Pile Voltage Regulator	28.5		For use with M-2, M-3, O-2, O-4 & P-2 Generators designed to plug into Standard Sub Base			2.6

THE INVISIBLE CREW — Precision Equipment by — Bendix — AVIATION CORPORATION

Aviation Accessories

Teterboro, New Jersey

for Distinguished Service to the World . . .

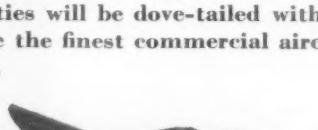
AMERICA'S UNIVERSITY OF AVIATION

Since July 1, 1939, Spartan School (Div. of Spartan Aircraft Co.) has been training aviation cadets for the U.S. Army Air Forces. This is in addition and completely separate to the School's extensive civil aviation training program which continues to furnish hundreds of technicians for the aviation industry, and for a fighting America. Spartan School and the Spartan College of Aeronautical Engineering (Div. of Spartan School) form America's outstanding University of Aviation.

ALL THE WORLD salutes you . . . United States Army Air Forces . . . and freedom-loving people everywhere pay homage to your triumphant accomplishments.

Across the length and breadth of America . . . in thousands of plants and factories . . . the aviation industry is concentrated on keeping you supplied with the vital implements of war. As a member of this important industry, SPARTAN is pledged to 100% war production until victory is attained.

After victory, our war-time developments and greatly increased manufacturing facilities will be dove-tailed with over 15 years of experience to produce the finest commercial aircraft ever to carry the SPARTAN name.



SPARTAN AIRCRAFT CO.

TULSA, OKLAHOMA

CONTRACTOR TO THE U. S. ARMY AND U. S. NAVY — BUILDERS OF FINE AIRCRAFT SINCE 1928

Air Bases—Everywhere

(*Continued from page 187*)

Army Air Force Service Group, which operates what is called a service center. Each such center furnishes third echelon maintenance, supply, reclamation and salvage for two combat groups. The combat groups may be dispersed on "satellite" fields many miles apart—admittedly the world's busiest, most vital suburbs.

The Service Group must see to it that all air supplies, spare parts, aviation gas, oil and bombs are delivered to a combat squadron at its airport. To accomplish this "sidewalk delivery," the Service Group is highly organized. Its units are the Station Complement or housekeeping establishment, in the field.

More than a nerve center is Headquarters and Headquarters Squadron whose functions include Medicine, Chemical supply, finance, quartermaster, instrument landing and photography.

Two service squadrons operate the Air Force engineering section and technical supply, taking care of third echelon maintenance and supply for combat groups.

Two quartermaster truck companies furnish motor transport for both combat and service groups. Two ordnance companies provide "garage" maintenance without the glitter and gadgets of America's super-service stations.

It falls to the lot of QM personnel to procure, store and issue quartermaster supplies to all units.

Combat units, in a theater of operations, often must move on instant notice. Propellers and some maintenance equipment will necessarily have to move by air. Ground mechanics also must go along to continue supply and maintenance of combat planes and crews.

Service group and combat group personnel have to match wits with the enemy, the land and climate of strange places. Making what they need with what they can find, these men can not go to the corner hardware store or the nearest warehouse and be served. They pioneer in ways their practical grandfathers never did and many an ingenious device has been developed from a piece of wire or fragment of scrap metal.

Combat squadrons might be on individual airdromes, or operate as entire groups from one airdrome. Units are self-supporting up to a certain point. They service aircraft and aeronautical equipment, make preflight and daily inspections, minor repairs, adjustments and replacements. All of their tools and equipment must be airborne. This the Army calls first echelon maintenance.

Second echelon maintenance involves the servicing of planes and aircraft equipment through periodic "safety first" inspections, and whatever repairs can be made by hand tools and such mobile equipment as had been issued the organization.

The Air Force Service Group is responsible for third echelon maintenance and supply, using mobile machinery and other equipment heavy enough to require surface transport.

The Air Force Depot Group, to go a step further, handles fourth echelon maintenance—all operations necessary to make damaged aircraft completely operational, plus periodic major overhauls of engines, unit assemblies, accessories, auxiliary equipment.

Thus it may be seen that all the advantages of the fixed base have disappeared. Every unit must operate under field conditions, often yielding interesting surprises:

An Allied advance unit which had been on Rommel's heels for two months without rest found a burlap bag among captured Italian supplies. In it were $650 worth of Italian lira. Armed with this, the unit's commander sent out his men who scoured the countryside and bought up turkeys, pigs, chickens, eggs, not to mention 150 gallons of red wine. As simply as this, captured money had eased the United Nations' supply load. Immediately after the feast, Italian lira appeared to lose its potency—but Allied troops had dined well before the market broke.

Captured enemy equipment is a true source of Allied supply.

Somewhere along the zone of advance during the Rommel chase, an Air Force jeep in an advanced unit broke down. A spring was badly needed but there were no spares. French troops were near at hand, however. An American soldier began to poke around in a French "attelier"—an advanced mobile machine shop. The French, who waste nothing, found an old piece of iron in a wadi—a piece of junk ready for the scrap heap. The two forces beat this piece of iron into a first-class spring and installed it. Saved from the graveyard, the jeep lasted many months more.

Spare tires worth several million dollars were captured from the Axis during one push just south of Tripoli. While not adaptable to Allied planes because of a variance in sizes, they will prove invaluable as replacement parts for the upkeep of captured aircraft.

Continued effectiveness of an air force is limited by its supply organization. An airplane without bombs, ammunition or gas is useless. Moreover, the modern airplane carries equipment so intricate that it will become unserviceable without replacement parts or equipment at the right place at the right time.

While it is possible to move aircraft over great distances on short notice, advance planning in supply and repair is a first essential. Obviously, supply of maintenance material is much less mobile than the airplanes supported, and their movement by air is the exception rather than

(*Continued on page 208*)

FLYING

"The DNB report says only three of you were killed today—the rest of you will have to go to Hell."

NOW IMMEDIATE DELIVERY

On LYON Adjustable Wood Shelving and Shoprobes

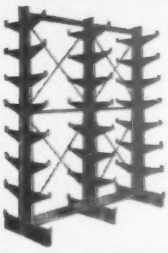
Lyon Wood Shelving
Strong, hardwood shelving adjustable every 3" vertically and horizontally by hand—no tools necessary. Complete assembly requires only one tool — a screwdriver! Quickly set up by inexperienced help. Easy to take down and re-erect in a new location. Open and closed types.

Lyon Shoprobe
Safe, convenient mobile storage for workers' clothing. Takes up less floor space per person than the area covered by a man's hat! Especially suited to industries where personnel fluctuates and compact, low cost clothes storage is a prime requirement.

AVAILABLE

CAN BE DELIVERED ON SATISFACTORY PRIORITY FOR INDUSTRIAL USE

These LYON Time-Saving Production Units



Lyon Bar Rack No. 28-36
Each section is 36" wide, 20-3/4" deep, 79-5/16" high. Arms on each side of uprights adjustable on 3" centers with spacing as close as 9" between arms. First and additional section as shown (42 arms) $58.25.

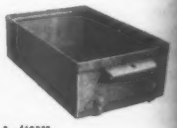
Lyon Work Bench No. 5100
With Half Depth Shelf, Back Stop and Two End Stops. 60" long, 28" deep. $17.55. Drawer 12" wide, 16" deep, 4" high. $2.95 extra.

Lyon Bench Legs No. 2401-11
28" x 32¼"
$2.95

Style "RB" Material Handling Container No. 445F11
10" x 20" x 8"—16 gauge Steel
$1.55

Style "L" Material Handling Container No. 410F16
11" x 22" x 6"—16 gauge Steel. $0.95

Style "O" Material Handling Container No. 425F11
11-13/16" x 22" x 7-3/8" — 18 gauge Steel. $1.75



Style "H" Material Handling Container No. 421F14
12" x 18" x 6"—18 gauge Steel. $1.60

Wire or mail your orders today. Write for catalogs showing other Lyon time savers for War Plants now available.

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PLEXIGLAS

...and modern plane *PERFORMANCE*

TO the pilots of 1918 Jennys and Spads, a speed of 200 miles per hour was unthinkable. Men couldn't possibly breathe in such fast and freezing slipstreams, let alone pilot a plane or aim a gun.

But they didn't foresee PLEXIGLAS. Today this crystal-clear plastic—formed into streamlined bomber noses, tail assemblies, gun turrets and cockpit canopies—protects the crew on every type of Army and Navy airplane.

Even in the extremely low temperatures of the sub-stratosphere PLEXIGLAS is strong and shatterproof. It is permanently transparent and will not discolor or warp in service. PLEXIGLAS is as clear as optical glass yet only half as heavy.

Recognized as "aviation's standard transparent plastic," PLEXIGLAS will also contribute to the comfort, safety, visibility and performance of your peacetime plane tomorrow.

Only Rohm & Haas make PLEXIGLAS

ARMY E NAVY

PLEXIGLAS *is the trade-mark, Reg. U.S. Pat. Off., for the acrylic resin thermoplastic sheets manufactured by the Rohm & Haas Company.*

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA, PA.

Manufacturers of Chemicals including Plastics . . . Synthetic Insecticides . . . Fungicides . . . Enzymes . . . Chemicals for the Leather, Textile and other Industries

All over America, the hundreds of civilian-owned and operated schools that make up the War Training Service are giving thousands of potential military pilots their first flight training. They are doing it quickly, economically, safely . . . playing a vital part in building muscles for Uncle Sam's air arm.

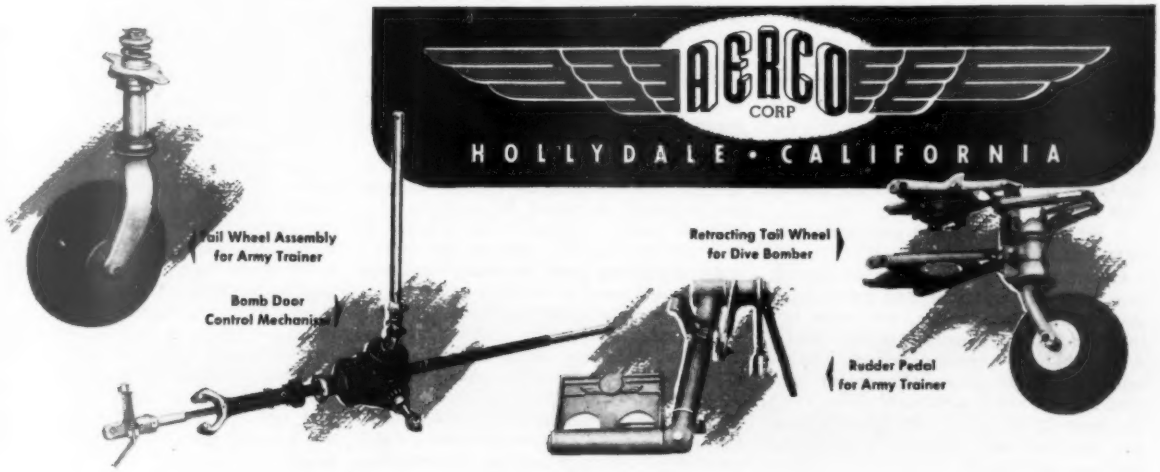
The War Training Service is doing its magnificent job with the same small ships that made up the country's pre-war fleet, making no call on the country's vital warplane production. These WTS planes, many powered by Franklin aircooled engines, are serving better under this intensive training grind than their manufacturers could ever have foreseen. Aircooled Motors Corporation is now making new and larger Franklin warplane engines, but it is proud that its peacetime power plants are also serving their country so dependably and economically in the ranks of the War Training Service.

AIRCOOLED MOTORS CORPORATION, SYRACUSE, N. Y

Franklin

In Appreciation of the new star recently added to our Army-Navy "E" award, we men and women of Aerco pledge still greater production records. Toward this we are working 'round the clock . . . turning out precision sub-assemblies with a minimum of rejections . . . holding down absenteeism and in every possible way contributing to greater output of equipment for the Army Air Forces!

AERCO CORP
HOLLYDALE • CALIFORNIA


Tail Wheel Assembly for Army Trainer
Bomb Door Control Mechanism
Retracting Tail Wheel for Dive Bomber
Rudder Pedal for Army Trainer

(*Continued from page* 203)

the rule by reason of the fact that transports are limited in all areas.

A "typical" AAF base in the United States is as large, as well supplied and almost as settled as a Midwest county-seat town. Like a busy civilian center, it has its fire department, chapels, business section, warehouse district and one or more residence zones.

To train personnel, test tactics and streamline its expansion program, the AAF has long had these great efficient communities at home. Domestic air bases, as any American may observe through the gates, include a landing field, barracks, mess halls, hangars, shops, hospitals and all other tools of our complicated war machine. Supplies arrive by standard transportation, usually on fixed schedules. Food, clothing and airplane parts require but a letter or telephone call. Laundry is taken for granted. Often a friendly town is at the other end of the bus line.

Weather alone can interrupt daily training operations.

Thanks to this continuous performance, a permanent organization can "housekeep" at an air base. The Air Forces call it the Station Complement, which includes these units:

1. Base Headquarters and Air Base Squadron, with about 50 officers and 300 enlisted men, performs administrative services and operation at bases of more than 2,000 personnel.

2. Band provides music for drills, inspections and soldier entertainment.

3. Guard Squadron is the base police force.

4. The Aviation Squadron builds roads, digs ditches, does other laborers' jobs.

5. Aviation detachments of other Army branches provide trained specialists in certain duties. Chemical Storage receives, stores and issues chemical supplies. Ordnance handles bombs, weapons and ammunition, helps maintain motor vehicles. Signal Service operates and maintains the base telephone system.

Quartermaster personnel receive, store and issue QM supplies, transport quartermaster equipment, other items as needed. Quartermaster Transportation operates vehicles assigned to the base. Finance pays military and civilian personnel.

6. Sub-depot provides third echelon maintenance of aircraft, which means repairs requiring mobile machinery and equipment too bulky for normal air transport.

7. Communications men operate ground point-to-point radio, ground-air radio and airdrome control radio—the air base's link with the world.

8. Weather Detachment personnel provide data vital to flight.

Consider, now, the problem of moving into an active war zone and establishing these same installations, not once but hundreds of times, as part of task forces. All personnel, supplies and equipment must go by boat or by air to present theaters. The enemy is a constant threat from the moment of departure. Needed landing facilities will probably have to be built or brought in.

Roads, rail lines, air bases, runways—everything must be built. The people may be hostile or just "fail to cooperate." Constant attack by the enemy may be expected. Weather freaks, undreamed of in Ohio or Minnesota, may be expected to take a toll of personnel and equipment.

The air base, as we know it in the United States, is found only in areas well removed from a combat zone. In active theaters, however, dispersed landing fields are employed. They may have one or more landing strips, depending upon time, terrain, weather conditions and the extent of enemy air activity. Construction, maintenance and camouflage of these fields is the job of aviation engineers.

Building our vast chain of military airdromes at home and abroad has added a historic chapter to American engineering. The chapter is not finished. Its most colorful pages are being written by air engineers today in tropical jungles and polar wastes.

Modern war has changed the very land from which planes take wings. Bombers that weigh as much as a railroad locomotive—and land at speeds faster than streamliners—need wide, long and tough runways if they are to remain intact for combat. Design of airdromes must keep pace with all other air progress. Today's airdrome combines the traffic load of a great rail terminal with a city's industrial shops and housing.

Airdromes are only half the engineers' program. Great modern aircraft plants, Government-owned, dot the country. Modification centers make last-minute changes and install special equipment in new aircraft. Custom tailors of warplanes, these modification centers free assembly lines for mass production of standard models. Most of them are air engineers' projects.

Speed of construction has paced aircraft development without sacrificing flying safety. Design and construction standards are unequalled by any other nation. Airfields must take maximum traffic, heavy loads and dangerous cargoes—all the gruelling punishment of military aviation which can afford no time-out for repairs or upkeep. Student flying and operational training in the United States, world-wide transport abroad, demand continuous ground facilities.

The typical flying school or fighter airdrome has paved runways 150 feet wide and a mile long, laid out in the directions of all prevailing winds and designed to carry planes weighing up to 15 tons. Airdromes for bombardment planes are provided with runways up to 7,000 feet long designed for 60-ton loads. Greater lengths are provided at inland fields where the altitude makes necessary higher take-off and landing speeds. Aircraft which require a runway 6,000 feet long on Long Island must have an 8,600-foot runway at Denver, a mile above sea-level. Special runways for instrument landings may be 1,000 feet wide and two miles long.

The immediate vicinity of an airport must be cleared of trees, buildings and other obstacles which might cause accidents. All the air approaches to a field are plotted on maps and the obstructions cleared above a flying angle out to a distance of at least two miles.

Servicing equipment has been built on a comparable scale. Lighting permits operations by night. Fuel storage and delivery systems can store a whole trainload of gasoline at one time. Acres of paved parking space have been built to accommodate the aircraft at each station and repair depot. These shops can house the biggest planes in use.

Innumerable special requirements dog the air engineer. Technicians and their works are everywhere. Mechanics must have facilities to repair fuselages, engines, guns, bombs, parachutes. Experts require delicate equipment. Radio operators, weather men and flight surgeons demand tools and laboratories. All have to be housed, fed, clothed and given the means for recreation if they are to perform with peak efficiency. All these facilities are part of the modern military airdrome.

War requires speed. These field airdromes, reduced to bare essentials, can be built in a hurry. But the skeleton of even the remotest airdrome is complicated engineering. Vast areas must be leveled and drained. Runways to support the huge wheel loads of military aircraft must be built. Gasoline storage tanks and pipe lines are required. Enormous quantities of ammunition and bombs must be stored and sheltered. Hundreds of men must be housed, fed and watered regularly and without delay. The aviation engineer needs the sense of urgency to accomplish in days or weeks the months-long work of peacetime.

Pacing AAF expansion, new types of engineering units have joined the standard construction battalion:

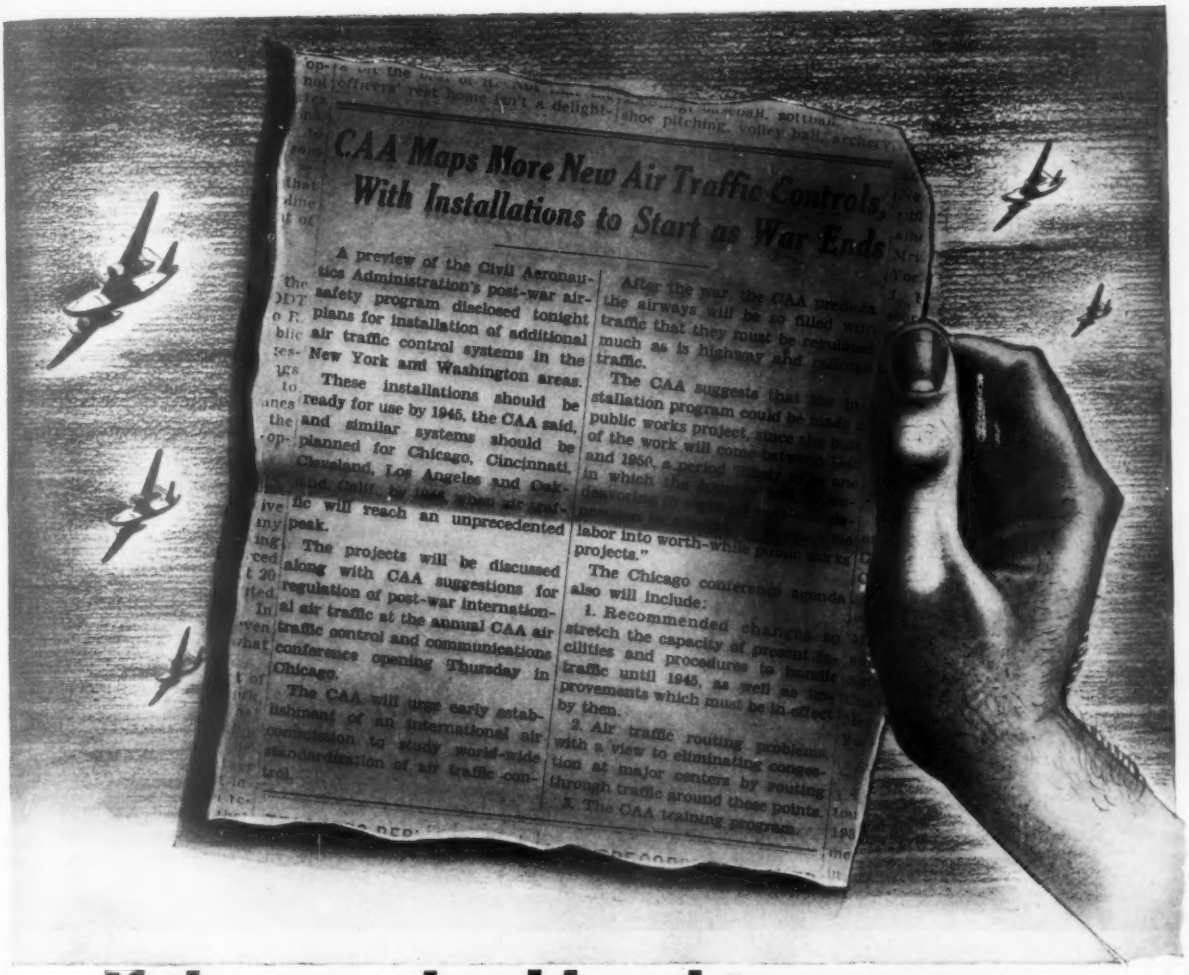
Camouflage experts match enemy wits on the spot. Headquarters companies design special installations to fit tactics. Topographic companies revise navigation charts, make approach and target charts for bomber crews. Newest specialty is the airborne battalion, whose portable equipment fits transport planes or gliders.

News of the year to every officer who must struggle with the world-wide problem of supplying our air bases on every continent is the "single chain" of supply now being established between the AAF and Allied air arms.

The AAF has begun to undertake responsibility for supply of maintenance parts for all "common usage" American-built planes and aircraft equipment operated overseas by Allied Air Forces in all theaters where an Air Service Command has been established.

Advantages of this streamlined supply system are obvious to anyone who has had to fight red tape as well as an enemy. Allied airmen will know the blessings of one supply channel for all overseas shipments from the U. S. Result: less paperwork, fewer headaches. Besides eliminating lost emotion and waste effort, Allied supply officers will have quicker access to much-needed parts and too, the AAF will be able to maintain complete records on all American-built aircraft.

These, then, are the men who establish and run the air base overseas. Their work is the source and sustenance of all flight. END


CAA Maps More New Air Traffic Controls, With Installations to Start as War Ends
A preview of the Civil Aeronautics Administration's post-war airsafety program disclosed tonight plans for installation of additional air traffic control systems in the New York and Washington areas.
These installations should be ready for use by 1945, the CAA said, and similar systems should be planned for Chicago, Cincinnati, Cleveland, Los Angeles and Oakland, Calif., by 1948, when air traffic will reach an unprecedented peak.
The projects will be discussed along with CAA suggestions for regulation of post-war international air traffic at the annual CAA air traffic control and communications conference opening Thursday in Chicago.
The CAA will urge early establishment of an international air commission to study world-wide standardization of air traffic control.
After the war, the CAA predicts the airways will be so filled with traffic that they must be regulated much as is highway and railroad traffic.
The CAA suggests that the installation program could be made a public works project, since the bulk of the work will come between 1945 and 1950, a period usually given in which the economists predict labor into worth-while public works projects."
The Chicago conference agenda also will include:
1. Recommended changes to stretch the capacity of present facilities and procedures to handle traffic until 1945, as well as improvements which must be in effect by then.
2. Air traffic routing problems, with a view to eliminating congestion at major centers by routing through traffic around these points.
3. The CAA training program.

If the war should end tomorrow . . .

RADIO RECEPTOR, with a wealth of experience encompassing the entire history of radio, would be ready to convert its greatly expanded facilities to the construction and installation of Ground-to-Air Navigation, Communications and Airport Traffic Control Equipment for civilian use.

Now devoted to the war effort, these engineering and production facilities that built the first commercial ultra-high-frequency airport control units, which were installed at Washington National Airport for the Civil Aeronautics Administration, will be in a position to provide all advanced types of airport radio equipment—for municipal and private fields—under a single contract, if desired.

Today, RADIO RECEPTOR installations assure increased safety and efficiency in airports throughout the world. We'll be glad to send a copy of our revised booklet, "HIGHWAYS OF THE AIR", now in preparation. Please write on your business stationery to our Executive Offices, 251 West 19th Street, New York 11, N. Y.

RADIO RECEPTOR CO., INC.

Awarded for Meritorious Service on the Production Front

SINCE 1922 IN RADIO AND ELECTRONICS

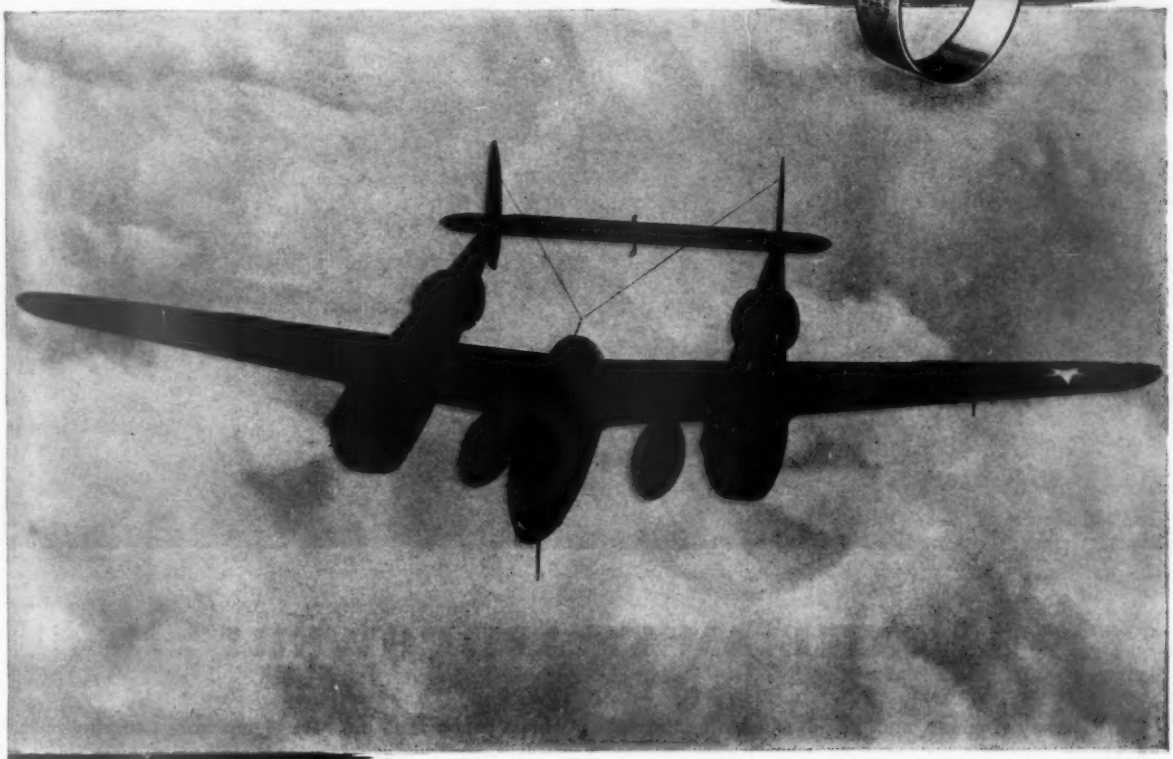
Today . . . Serving Democracy in *three vital* war activities — (TG-6) Training glider pilots for invasion of the Axis strongholds . . . (L-2) As the *Eyes* and *Aim* of the Artillery, making every shell count . . . (Commercial models) Creating new Pilots under the War Training Service and carrying Civil Air Patrol Pilots on heroic though unpublicized defense missions.

Tomorrow . . . Ready to serve Democracy's post-war flying public with the same high ideals of *safety*, *economy*, and *dependability* that have *always* characterized *Taylorcraft* airplanes, in Peace or in War.

TAYLORCRAFT AVIATION CORPORATION

ALLIANCE, OHIO

Amazing Performance at Extremely High Altitudes



LOCKHEED P-38 LIGHTNING *is equipped with* WITTEK *AVIATION* HOSE CLAMPS

Flying faster, higher and farther than any enemy fighter . . . taking punishment, yet still delivering the goods—the Lockheed P-38 Lightning is equipped with Wittek Aviation Hose Clamps. Today, as in the past, Wittek Aviation Hose Clamps, known as the standard of the industry, are being used by the nation's leading military aircraft and engine builders. Wittek Manufacturing Co., 4305-15 West 24th Place, Chicago 23, Ill.

ARMY E NAVY

...BUY MORE WAR BONDS...

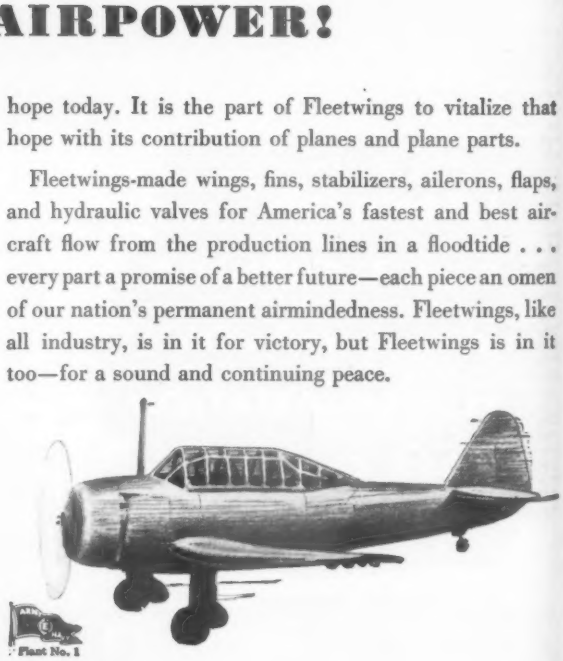
WITTEK *Aviation* HOSE CLAMPS

TAKE AWAY AIRPOWER!

TAKE away airpower, and the job of winning the war becomes terrifying in its immensity. Our strategy of fluidity, surprise, and preparatory softening would stagnate to one of position with military advances measured in feet instead of hundreds of miles. Everywhere on the globe, footholds in enemy territory would be gained only at calamitous loss of life.

Is it any wonder that America's eyes are turned skyward? Isn't it natural for us to depend on aviation to bring an earlier end to the war, and to assure the continuance of peace by making neighborliness the keynote of worldwide diplomacy? Airpower, a faint shadow over the world in 1918 has become the very substance of our hope today. It is the part of Fleetwings to vitalize that hope with its contribution of planes and plane parts.

Fleetwings-made wings, fins, stabilizers, ailerons, flaps, and hydraulic valves for America's fastest and best aircraft flow from the production lines in a floodtide . . . every part a promise of a better future—each piece an omen of our nation's permanent airmindedness. Fleetwings, like all industry, is in it for victory, but Fleetwings is in it too—for a sound and continuing peace.



Plant No. 1

FLEETWINGS

FLEETWINGS

pioneers with parts and hydraulic equipment

The BT-12, all-welded basic trainer built for the U. S. Army Air Forces.

WELDING SCHOOL GOES MODERN Because the old apprentice method of teaching welding was too slow for wartime production speed-up, Fleetwings' welding school has streamlined its course and is turning out first class welders in double-quick time. The whole subject of welding is taught thoroughly. Instructors insist that each worker understand the theory and principles of welding before doing any practical work. And, as a part of the training, students follow a regular welder through his routine work—learning first hand how welds should be made.

NEW IDEAS DEPARTMENT When the rivet sorting problem became acute at Fleetwings, the Special Tool Development Department came to the rescue with a sorting device guaranteed to save man hours aplenty. It's nothing but a turning barrel screen on the order of those used in collieries for grading coal. With it, one operator can match the turnout of twelve workers using the old hand sorting system.

HYDRAULIC VALVE DIVISION Fleetwings pioneered in the aviation valve industry for its own ships and is still pioneering in production methods and shortcuts. As war work multiplies, Fleetwings' hydraulic valve division follows through with greater precision and finer craftsmanship. Watch for the announcement of a new group of slide selector valves.

THE ARROW, Fleetwings' monthly magazine, will help you to keep informed. In its pages are described the new production methods, shortcuts, and news of interest to men and women in the aircraft industry. If you'd like to receive a copy each month, write us on your company stationery. Send your request to "THE ARROW," Fleetwings, Inc., Bristol, Pa., Plant No. One.

FLEETWINGS

Division of Kaiser Cargo, Inc.

BRISTOL • PENNSYLVANIA

Aviation Medicine

(*Continued from page* 161)

point where an unstable person may cause the defeat of the unit.

"Screening" applicants for flying training is a weapon beyond price. Lives and material and money are being saved by classifying a man before he ever gets into the air. Because of wartime secrecy laymen sometimes fail to realize how much knowledge has accumulated. Actually, aviation medicine not only can judge whether a man should fly: It can predict whether the applicant should be trained as a pilot, a bombardier or a navigator.

The angry father who writes his Congressman to insist that his son be given a chance to fly—despite a "screening" test that says "no"—may be causing the son's death and hindering the war.

There is another reason why flight surgeons must be exceptional doctors. Their highly-trained charges are *individually* responsible for expensive equipment. Airmen live more extensively while on combat duty than other soldiers. The stresses to which flying personnel are subjected—anoxemia, bends, centrifugal forces and long continued operations—bring out serious reactions that might never appear in less highly-keyed individuals. This requires more than average skill in diagnosis.

For the flight surgeon, diagnostic ability also involves tactics

Because this is a mobile war, the AAF soon discovered that the evacuation hospital of World War I would not do. A large evacuation hospital is immobile and vulnerable.

The Army Air Forces therefore converted giant cargo planes into flying ambulances, equipped and staffed to carry the sick and wounded to hospitals back home. Our pilots flew cargoes into the combat zones—and then loaded human cargo into the same ships on the return trip.

Air evacuation serves to maintain high morale among our fighting men. They know they are never more than a few hours from America's most skilled physicians. Aboard each of these airplane ambulances there is either a flight surgeon or an Army nurse and one noncommissioned officer of the Medical Department. They provide detailed medical attention, even administering blood plasma and oxygen.

In New Guinea, evacuation by foot or on pack animals over the Owen Stanley Mountains from the fighting front to the field hospitals is a three-week journey. Air evacuation takes less than one hour. All casualties in this area have been evacuated by air. From the Indo-China front a critically injured soldier was evacuated by air in eight days to an Army hospital in the United States. The same trip by land and sea would have taken approximately three months under present conditions.

The AAF has evacuated 18,000 sick and wounded men—Americans, British and French—from the African theater alone.

Air Evacuation nurses—all volunteers and graduates of the Army's School for Air Evacuation Nurses at Bowman Field, Ky.—cross burning African wastes, the wide Pacific, to bring out wounded men in flying hospitals. Transport planes of the Army Air Forces can be converted in a matter of minutes.

Litters can be quickly snapped into place by means of stanchions or web straps—three tiers of them, on both sides of the ship. An ambulance chest, standard equipment on every ship, provides necessary medical supplies needed during flight for care of casualties. Special apparatus for administering oxygen is in its place, ready for instant use. Big troop carrier planes can carry amazingly large numbers of casualties.

Effects of high altitudes on a patient's condition have to be taken into account. For instance, certain medicine dosages have to be increased, others sharply reduced.

Air evacuation personnel must know about such rare tropical maladies as dengue fever, yaws, filariasis; must study aero-medical physiology, aero-medical nursing, classification for air evacuation, air ambulance loading, crash procedure, Arctic hygiene.

Casualties to be air-evacuated are selected by a flight surgeon who classifies them as to priority of evacuation. A graduate of the School of Aviation Medicine at Randolph Field, Tex., he must know which type of case can be sent to the hospital by plane, which cannot. Air evacuation of certain types of casualties would be fatal. The flight surgeon must decide.

When the big hospital planes come down for refueling stops, the flight surgeon makes regular "hospital rounds" of the planes composing the flight, checks the condition of each patient, prescribes necessary treatment for the next leg of the trip.

Air evacuation has two primary functions. First is to improve the combat efficiency of the armed forces by rapidly relieving combat units of their non-effectives. Second is to reduce the number of evacuation and hospitalization units required for a theatre by air transport of convalescents to interior zones.

Army authorities declare that in less than 48 hours, 21 transport planes can carry 500 casualties a distance of 4,000 miles away from a combat zone.

To hospitalize the same number of patients without air evacuation would require several trainloads of equipment, plus tons of supplies each week for care of patients and maintenance of medical personnel.

Air evacuation is the fastest and safest method of evacuating wounded from combat zones, provided air superiority is maintained.

One Troop Carrier group was cited by Secretary of War Henry L. Stimson for "outstanding performance of duty"

(*Continued on page* 218)

Also Training

MEN and WOMEN

Civilian Pilots

Anderson Air Activities could be classified as "100% on war work," yet at least two angles are primarily civilian.

To both men and women not in the military forces, Anderson Air Activities offers a wartime entry into an industry that is expanding to the height and breadth of the sky! Although Anderson instructors are training men under contract for the U. S. Army Air Corps it has proved possible to enroll a limited number of civilians in our Milwaukee School.

Women pilots can play an important part in the Air War. As Anderson-trained pilots they can serve the Ferry Command in delivering planes, carrying supplies and messages.

Men who are too old for combat flying or the draft, but who otherwise qualify, can receive Anderson flight training that will fit them for positions as instructors.

Men and women who feel themselves suited for such positions with Anderson training are invited to write me about their abilities and aspirations.

ANDERSON *Air Activities*

Address Correspondence to ANDERSON AIR ACTIVITIES, Chester Field, McBride, Mo. Home Base: General Mitchell Field, Cudahy, Wisc. Branches at Fond du Lac and Antigo, Wisc.

CONTRACTORS TO THE U. S. ARMY AIR FORCES

ARMY'S B-26 MARAUDER

THEY'RE WRITING HEADLINES
WITH A

MARTIN MARAUDER

BRITAIN'S BALTIMORE

ALEX . . . JOE . . . STEVE . . . ED . . . and BILL. You know them. Alex, who used to bring your groceries . . . Joe . . . Steve . . . Ed and Bill, who used to go with little Sally Miller. Likeable, quick-to-laugh young Americans. Give them the best aerial schooling in the world, put them in a rocket-fast, Martin B-26 Marauder, and they're a flyin', fightin' team that wins!

There's a reason for this, of course. Aircraft are highly complicated mechanical devices . . . and these boys were fitting together gadgets, tinkering with tools, racing old jalopies, when their adversaries were learning to "heil" and "banzai." They've got the feel of speed, the mechanical know-how that makes natural pilots, gunners and bombardiers.

This same technical skill gives America fighting planes like the Martin B-26 Marauder. Sleek, graceful, packed with speed, power and punch, it's the kind of plane that makes young America's eyes light up . . . makes him say, "Put me down for the Air Force!"

What's more, American technical skill is going to play a major role in fashioning the future. Already Martin has designed giant airliners of 125 or more tons . . . mighty ships that will bring distant nations to within hours of your doorstep. At the same time, our Army and Navy airmen, imbued with the thrill of flight, the love of speed, are resolving never to be shackled to earth again. They're in the air . . . to stay!

Alex... Joe... Steve... Ed... and Bill.
They're doing more than win a war. They're building a world that will take your breath away.

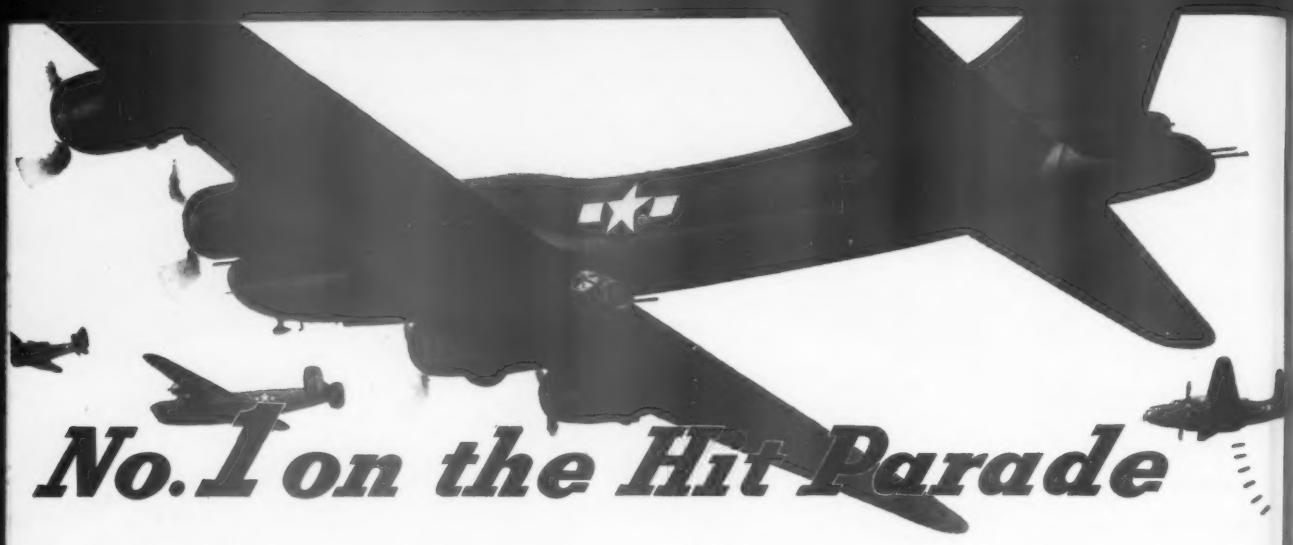
THE GLENN L. MARTIN CO., BALTIMORE
THE GLENN L. MARTIN-NEBRASKA COMPANY—OMAHA

NAVY'S MARTIN TRANSPORT

NAVY'S MARINER PATROL BOMBER

Martin
AIRCRAFT

Builders of Dependable Aircraft Since 1909



No. 1 on the Hit Parade

"WORDS AND MUSIC" BY DOUGLAS EMPLOYES

Dedicated to the Flight Crews and Ground Personnel of the United Nations

THE "Hit Parade of the Centuries" is on the march down the sky-road of retribution that stems from this nation's aircraft production lines. With the mounting fury of our offensive, each bomb that hits its Axis mark is one more note in the dirge to be finally titled, "Unconditional Surrender."

Leading the nation in quantity, quality and types of warplanes produced are more than 150,000 loyal men and women of Douglas. In six mammoth plants, strategically located from the Great Lakes to the Pacific Coast, their craftsmanship and devotion to duty back up the skill and daring of the men who fly Douglas-built airplanes on every front.

United Nations fighters and Douglas workers make up a Victory Chorus in whose score are heard the roar of dive bombers and attack bombers; the thunder of great four-engine long range precision bombers; the drone of cargo and transport aircraft that are day and night "carrying the Ax to the Axis."

No pretty tune for our enemies, but an inspiration of hope and assurance of liberation for the world!

Douglas

AIRCRAFT COMPANY

SANTA MONICA, CALIFORNIA

LONG BEACH, CALIF. ★ EL SEGUNDO, CALIF.
CHICAGO ★ TULSA, OKLA. ★ OKLAHOMA CITY

MEMBER, AIRCRAFT WAR PRODUCTION COUNCIL, INC.

SANTA MONICA

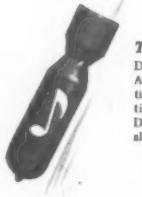
Here at Douglas headquarters, tens of thousands of diligent men and women are working around the clock turning out record numbers of A-20 "Havoc" Attack Bombers and C-54 "Skymaster" Combat Transports. The "Havoc" has been termed the most vicious of all tactile plane of the war. The "Skymaster" is the world's largest transport in volume production.

EL SEGUNDO

The men and women of Douglas at El Segundo are proud Army-Navy "E" Award winners for outstanding production of SBD and A-24 "Dauntless" Dive Bombers —the planes that have borne the brunt of the fight in the Pacific. Among Allied manufacturers, Douglas is the largest dive bomber producer and has turned out more planes of this type than all other American manufacturers combined.

LONG BEACH

Here in one of the world's largest, most modern aircraft plants, production lines are humming, turning out famed C-47 "Skytrains," C-53 "Skytroopers" and B-17 "Fortresses." In addition to producing fabulous quantities of the two transport types, Douglas Long Beach workers have produced "Fortresses" far ahead of schedule.



TULSA

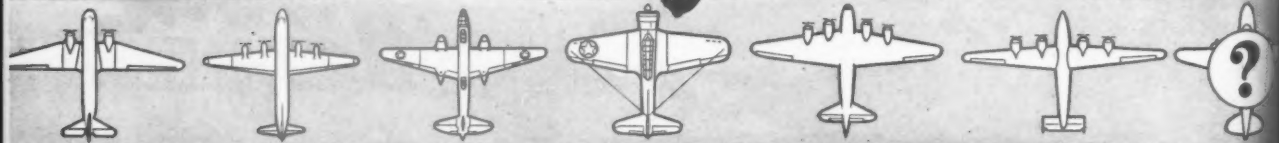
Douglas is the only manufacturer of both types of American four-engine bombers. At Tulsa the production of B-24 "Liberator" bombers is swelling as a rising tide. In addition, the proud Oklahomans who man Douglas production lines are contributing their full share of deadly A-24 "Dauntless" Dive Bombers.

OKLAHOMA CITY

The men and women of Douglas lead the nation in building vitally needed cargo and troop transport airplanes. Devoted to the exclusive production of C-47 "Skytrains" and C-53 "Skytroopers," Douglas Oklahoma City aircraftsmen take pride in producing the planes that are keeping our lifelines open throughout the globe.

CHICAGO

Located at the future "crossroads of the world" is the largest factory devoted exclusively to production of transport aircraft. Here huge four-engine C-54 "Skymaster" Combat Transports were being assembled before completion of the plant. Now getting into full swing, Douglas at Chicago will be turning out the world's largest standard transport at a yearly rate exceeding all transports in world airline use before Pearl Harbor



C-47 "Skytrain" Cargo Carrier | C-54 "Skymaster" Combat | DB-7 "Boston" and A-20 "Havoc" | A-24 and SBD "Dauntless" land | B-17F "Flying Fortress" high | B-24 "Liberator" high alti- | WOULDN'T HITLER

On the Double

FOR THE DURATION

On the Double is the order of the day at Southwest Airmotive. Located in Dallas, the Nation's Aviation Capital, Southwest Airmotive is the largest maintenance and overhaul plant in the United States.

Originally founded to give *air line maintenance to the private owner,* most of Southwest's skills are now under contract to the Army Air Force. But, we are *on the double,* doing our best to serve the civilian flyer, too. We know you realize the Army must receive preference and there may be occasional delay.

Additional facilities, new methods and techniques are constantly increasing the efficiency and integrity of our work. The skill and experience thus being gained is your assurance of a job well done, *now* and in the peace to come.

Phone, write or wire us your trouble. Whether it is a simple cotter pin or a complete overhaul, we'll "bust a prop" to help you.

COMPLETE STOCKS OF NATIONALLY KNOWN PARTS AND ACCESSORIES

THE SERVICE ROUTE IS VIA **Dallas** *THE NATION'S AIR CAPITAL*

"Airline Maintenance For The Private Owner"

(*Continued from page* 213)

against the Japs in Papua, New Guinea. The group flew troops and 100 tons of supplies a day into battle areas, flew out with casualties to hospital zones far back of the battle areas. Members of the group "repeatedly exposed themselves in their cargo planes to attacks by enemy aircraft and antiaircraft," the War Department has noted.

Rations were dropped by plane. A complete portable hospital was flown in and set up on the field. All this was done through a rain of fire from Jap planes which American and Australian flyers repulsed.

In North Africa, air evacuation flew combat troops more than 1,000 miles in the opening phases of operations, later evacuated the wounded a like distance beyond combat areas.

One African field hospital got a radio message from a remote base 1,000 miles away that a soldier there was sick internally. The hospital radioed back requesting the base to describe symptoms. This was done. Hospital personnel then radioed advice on emergency treatment and dispatched a plane which brought the sick soldier to the hospital that evening. Wartime aviation medicine has become the country doctor over a range of hundreds of miles.

Chief reasons for America's low casualty rate in this war are these: blood plasma, quick evacuation to medical treatment, sulfa drugs and surgery.

Blood plasma is surprisingly easy to handle overseas. Only real precaution needed is to keep the dried plasma out of sunlight. It is best kept in a cool place but even this is not absolutely necessary. Plasma, in fact, is preserved more easily than photo films.

Aviation medicine early recognized that medical supplies used by the Army Air Forces must be light in weight, compact, and durable to withstand extremes of temperatures and high altitude.

Light weight is paramount in air transportation. Therefore tablets are used instead of fluids. Fluid drugs must be packed in custom-built containers with a special type of stopper to prevent leakage at high altitudes. Other fluids will freeze in ships due to the extreme drop in temperature. Tincture of iodine, which is considered to have a very low freezing point, has actually been frozen solid during flights over Australia and Africa.

A typical example of ingenuity in wartime is the specially printed cardboard now carried in transport planes. This cardboard is ruled in various patterns with instructions printed on so that any soldier who can read can cut the cardboard into emergency splints for fractures of arms or legs, even for supporting the whole body in back injuries.

There are first-aid kits made for winter snows and desert sands. There are kits for snake bites, insect bites and poisonings. Kits shaped into frying pans contain medicine, sulfa tablets, drugs, bait and hooks—everything but the fish for sea emergencies. The AAF has even equipped life rafts with solar stills, enabling our flyers to condense sea water into fresh drinking water.

One supply headache is the variety of first-aid packets or kits required. Thousands of dollars have been saved by the reduction of drugs and material in certain kits and assembled items. An example of this was the reduction of the kit zipper one-third of its previous length, a saving of over $100,000. In trying to conserve medical supplies the Conservation Section of the War Production Board continually seeks substitute materials. In one case, precious aluminum was saved by substituting laminated wood and steel in litters.

Biggest problem is supplying the demand. Delay is sometimes inevitable. Raw materials and manufacturing facilities must be available.

Nor is every supply crisis without humor. Air Transport Command refused to carry rhesus monkeys—used for medical experimental purposes—from India, because no one had oxygen masks for the chattering animals.

Medicine needed in an emergency was delivered to an Allied warship several hundred miles at sea by a bomber crew of the Sixth Air Force. The medicine was flown in an AAF transport plane from a base hospital to a Central American airfield two hours after the radioed call for help. Then it was taken to sea by a *Liberator* and dropped into a life raft from low altitude.

Supply depends upon the home front, too.

Women now roll olive drab or khaki bandages — but not white — for the Red Cross. The reason? A white bandage defeats the best camouflage. The U. S. dye industry made this innovation possible.

Natives in Africa and the South Pacific are also the flight surgeon's job. Their health affects our men at nearby bases. Ordered to take preventive "shots," they seem to like it. The flight surgeon, of course, is smart enough to color this routine duty with a bit of hocus-pocus. Whole villages have been saved from epidemics and this gives the AAF physician more influence than the old-time witch doctor.

In the long-range view, the effect of AAF medicine during the past two years probably has been greater than decades of work by earlier agencies.

Island natives have assisted many times, often in bad weather, in rescuing AAF personnel forced down at sea. Other natives have been extremely useful as medical laboratory technicians, learning to do simple, fixed routines.

Research in AAF aviation medicine is primarily concerned with two things, selection of men for flying training and the investigation of problems concerned with increasing the efficiency of AAF personnel aloft and on the ground.

Two large research agencies operate under the co-ordination and control of the air surgeon: Wright Field's Aero Medical Laboratory and the School of Aviation Medicine, Randolph Field, Tex.

The Aero Medical Laboratory develops materiel designed to improve the efficiency of airmen. A part of the Experimental Engineering Division of the Materiel Center, it consults with engineers responsible for materiel developments.

Higher ceilings of airplanes have made oxygen equipment of prime interest. The Aero Medical Laboratory has, in a large part, been responsible for the development of high-altitude oxygen equipment. Our Air Forces are now provided with the best oxygen equipment in the world.

The Laboratory also has studied rations, acceleration problems, clothing, emergency equipment, goggles and many others, all practical.

The School of Aviation Medicine trains flight surgeons and does personnel research. Three hundred aviation medical examiners are graduated every six weeks.

The course consists of six weeks of study at the School of Aviation Medicine, followed by six weeks of practical work in one of the three aviation cadet centers. Expanded research laboratories are most concerned with selection of Army Air Forces personnel and medical problems. Research work on psychomotor apparatus centered here. Problems in regard to the effects of drugs, color vision, physical standards, psychiatric questions, air-sickness, and many others have been undertaken.

The school also trains aviation physiologists responsible for the successful operation of the altitude training program.

Realizing that equipment and manpower go hand in hand, the Office of the Air Surgeon initiated the unit oxygen officers' program. Responsible for good oxygen discipline in the field, these officers are trained at the School of Aviation Medicine research laboratories. On active duty, they fit masks, check oxygen regulators and aircraft installations, insure that adequate supplies of oxygen are maintained and that oxygen servicing facilities are available.

Spectacular research, however, still depends upon the flying doctor who has to convince himself, first of all.

Lieut. Col. William R. Lovelace, surgeon and AAF expert on high-altitude equipment, parachuted in midsummer from 40,200 feet—highest on record in this country—to prove how good our emergency oxygen equipment is.

Masked and goggled, he floated downward for 24 minutes, froze his left hand, proved that parachute jumps can match the altitude of present planes. END

Army Nomenclature

THE Army Air Forces has assigned the following letters to indicate the designations of its aircraft:

A....Attack
G....Autogiro
B....Bombardment
C....Cargo (Transport)
FM....Fighter (Multiplace)
L....Liaison
OA....Observation (Amphibian)
F....Photographic
P....Pursuit (Fighter)
PB....Pursuit (Biplace)
R....Rotary Wing
PT....Training, Primary
BT....Training, Basic
AT....Training, Advance
X....Experimental
Y....Service Order

Happy Landings

FOR GLIDER-BORNE TROOPS

The giant Commando gliders—newest "cogs" in our air forces' Victory machine—are effectively equipped with Scott Tail Wheel Assemblies to facilitate easier ground-handling—more ground maneuverability.

Developed by Scott specifically for glider installation, these special assemblies are patterned after the standard Scott Full Swivel design. Exceptionally light in weight, rugged and shock-resistant, these glider units are marked by an unusual production advantage: *no strategic war material is employed in their construction.* Even the tires are a special molded, composition in place of rubber!

SCOTT *Full-Swivel* TAIL WHEEL ASSEMBLIES

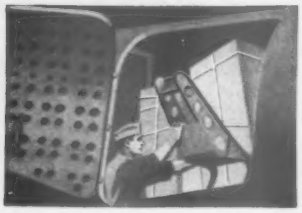
And as another contribution to Victory joins the growing Scott family of air craft accessories and special equipment which now includes Oxygen Manifolds...Oxygen Regulators...Brake Pressure Units...Control Wheels ...Stabilizer Yokes...Rudder Horns...Aileron Bell Cranks and 40-E *Scott-Cast* Aluminum Alloy Castings.

Your inquiry on special equipment problems answered promptly and in strict confidence.

Scott Aviation flies the Army-Navy "E" Flag for production achievement.

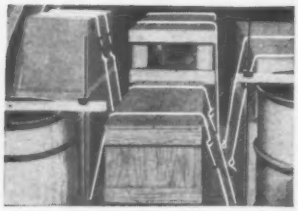
Scott
AVIATION CORPORATION
LANCASTER, N. Y., U. S. A.
DESIGNERS AND MANUFACTURERS OF SPECIAL EQUIPMENT FOR THE AIRCRAFT INDUSTRY

...LIERS TO THE U. S. ARMY AND NAVY AIR FORCES AND LEADING AIRCRAFT MANUFACTURERS



Loading a modern air cargo ship. Evans Skyloader equipment holds any load safely; means more payload, easier loading and unloading.

Hold-down beams securely locked to hook-rods are part of the Evans Skyloader system. Center cases are held firm by rope tighteners.



Even mixed cargoes reach destination snug and secure, held down by Evans Skyloader equipment which eliminates all slack in the load.

trade winds of the future!

From the days of the old windjammers to the roaring, silver ships of the sky, man has linked his destiny with trade over the seven seas. A new time-saving factor—air cargo—will, when peace comes, hasten restoration of world commerce, open up new markets, blaze new trade routes to distant lands.

Right now, weapons and supplies are rushed, via air cargo, to over 43 global battlefronts. A new industry is being born. Trade always follows the flag!

And in this pioneering of air cargo, Evans Skyloader Hold-down Equipment has simplified the difficult task of making fast all types of shipments. It provides safety to cargo, plane and personnel . . . saves countless, valuable manhours . . . is a vital, lusty force in the Trade Winds of The Future!

★ ★ ★

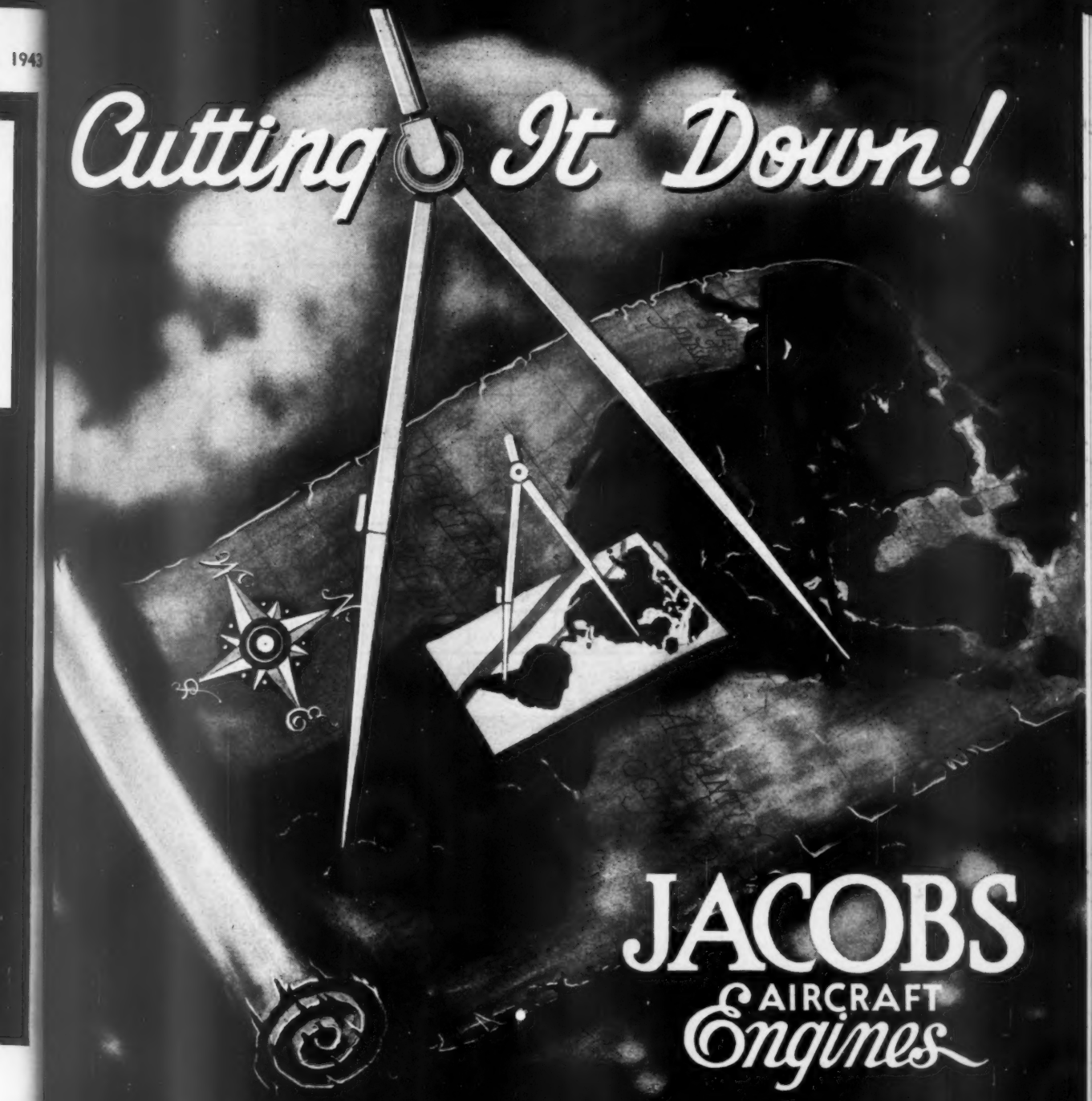
Vision to Anticipate the Needs of Tomorrow Creates New Industries Today

L. Evans PRESIDENT

EVANS PRODUCTS COMPANY

DETROIT

Evans War Products: Machine Gun Mounts • Tank and Automotive Heating and Ventilating Equipment • Aircraft Engine Mounts • Airplane Landing Gear Beams • Battery Separators • Prefabricated Houses • Plywood • Evans Skyloader • Evans Utility Loader • Evans Auto Loader • Evans Auto Railer



JACOBS AIRCRAFT Engines

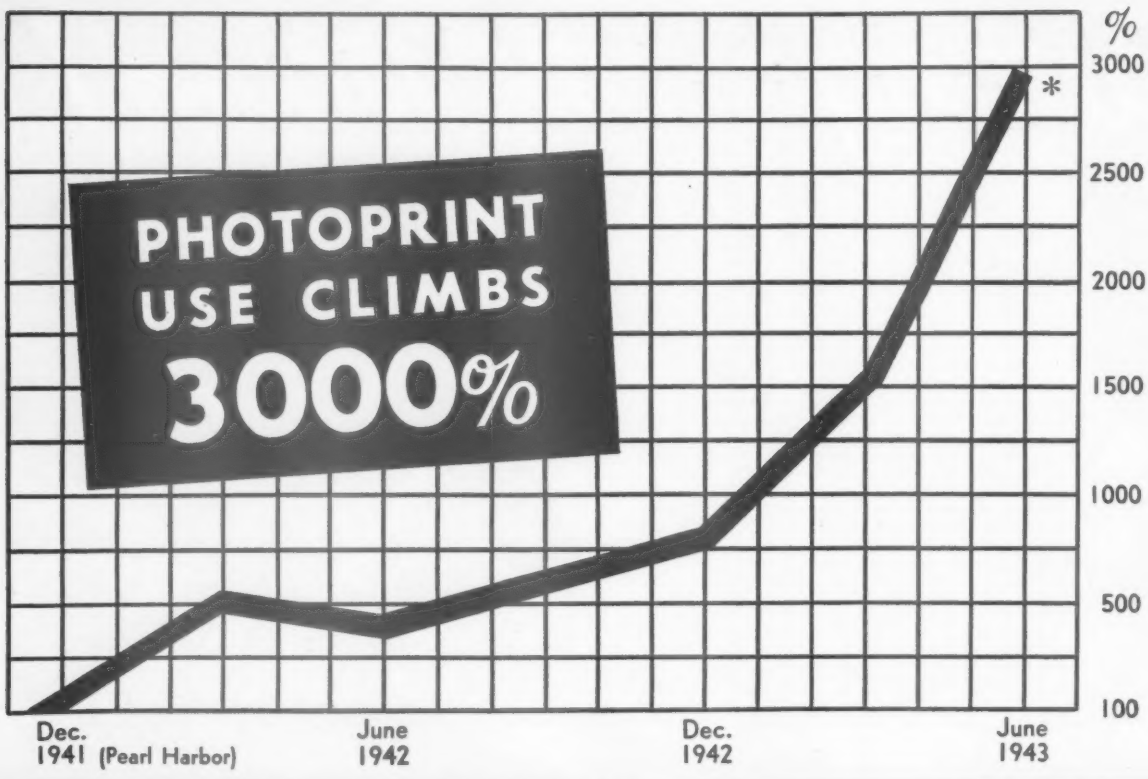
The old map is rapidly being cut down—distances are being reduced from days or weeks to hours.

The countries of Latin America, once our distant friends, are truly becoming our next-door neighbors. Inter-American travel will grow by leaps and bounds after the war. The vacationist will be able to swim at the glorious beaches of Rio on Saturday and be back at work Monday. Round trips on business during the week will be commonplace.

Modern light Airliners, powered by efficient, dependable Jacobs Engines, will provide rapid and easy travel from the international airline terminals to the interiors of these countries, opening their unlimited resources and beauty to us all.

All this will come after the war—but how soon it will come depends on how well we do our War Job NOW.

JACOBS AIRCRAFT ENGINE CO.
POTTSTOWN, PENNSYLVANIA, U. S. A.



FLYING PHOTOPRINTS
SPEED AIRCRAFT TOOLING IN THESE LEADING PLANTS

Photoprint departments are in operation at **Consolidated, Brewster, Briggs, Douglas (Long Beach), Fleetwings, General Motors, Goodyear, Interstate, Ryan and Vought-Sikorski.** New installations are now being made at **Douglas Santa Monica and El Segundo plants, American Aviation, and Willys-Overland.**

*Installations not yet completed are not reflected in these figures.

PHOTOPRINT COMPANY

5867 TOWNE AVENUE • LOS ANGELES • CALIFORNIA
ELIZABETH, NEW JERSEY

Snap-on Tools

HELP BUILD LOCKHEED'S FAMED HUDSON BOMBERS

"Sub smashers" they're called . . . these rugged, reliable Hudson bombers that have achieved glory in hundreds of brilliant combat actions . . . and which hold the official RAF coastal command record for having smashed more subs than any other warplane.

In Lockheed's great plants, Snap-on tools are busy helping speed disaster to the Axis . . . helping build the famed Hudsons, Lightnings and Vega Venturas. Swift, flexible, powerful Snap-ons are the favorite tools of thousands of Lockheed's skilled craftsmen and are made available to workers through Employees' Tool Stores, both at Lockheed and Vega. The 3,000 tools in the Snap-on line are distributed through 35 factory branches located in key aviation centers. Write for catalog and address of the nearest branch.

SNAP-ON TOOLS CORPORATION
8024-J 28th Ave. • KENOSHA, WIS.

Mission

(*Continued from page 79*)

"I already have figured the bombing conditions three times but will do so again. I can't afford to miss today. If I do, I'm sunk."

Then follows his conversation as he took over:

"Okay, Bill, turn on the target now . . . back to the left about 5° . . . okay, we're perfect now . . . everything's set . . . good grief! . . . the squadron ahead's tearing hell out of the place. . . . Boy! I can see their bombs through my sight. . . . Check, check, check and recheck . . . . all okay . . . Lammers, stand by the camera . . . level, now . . . level . . . just a few seconds and we can turn . . . here they go . . . camera! . . . *bombs away!*

"Okay to turn now . . . fighters coming up at three o'clock. Boy, those bombs had to be in there because I had it perfectly synchronized . . . fighters at 11 o'clock and at three o'clock . . . seem to be attacking the low group. . . . Look, Jim, a B-17 in trouble . . . look at those fighters swarm him. . . . There he goes now. . . . Poor devils in chutes going down through that flak! . . . Here come the *Spitfires!* . . . Are they *Spits*, Bill? . . . Do they look like *Spits* to you? . . . Yes. . . . Okay, taking no chances. . . .

"There's Rouen. . . . Looks like a graveyard . . . no trains . . . no tracks . . . burnt out. . . . Wish I could see the Renault works tomorrow. . . . Bet it looks like Rouen does now."

Lieut. Philip T. Palmer, of Wellington, Kan., says:

"The greatest tension is just before you start to work on the sight. Once you're started, you don't have time to think. It has to be automatic. You have to know your job almost subconsciously—and do it quick."

Capt. Leonard V. Santoro, of Kansas City, Mo., says:

"On your bomb run you have to concentrate until your first natural instinct, fear, is out of your mind. You have to ignore the fighter attacks and the flak that mushrooms in front of you."

To this, Lieut. Steve H. Lindley, of Gatesville, Tex., adds, "the bombardier is in a position to see the flash of the ack-ack guns on the ground and he has to sweat it out while he waits for it to burst."

Capt. Dean W. Boylan of Rantoul, Ill., describes those last few seconds this way:

"You are making your adjustments, and then you hear the flak. It sounds like someone ripping a hole in a bass viol. You look ahead and see one or two fighters barrelling in as if they were trying to beat their own bullets to you. You can't dodge. You just pray they'll miss you. Next come the minute adjustments, and then—bombs away!"

"And when the bombs are away," adds Lieut. John W. Beauchamp, of Coolidge, Ariz., "You're mighty ready to grab yourself a handful of gun and start shootin'. And when those bombs hit the target, a grand and glorious feeling runs up and down your spine, and the world looks brighter, even through a gun sight."

"A lot of things go through your mind during those seconds the bombs are dropping," says Lieut. Maurice J. Sullivan, of Burlingame, Calif. "You think about all the training you've had. You wonder if any of it did you any good. And then you see them hit, and you know everything is okey-dokey. You grab your guns and fire—but somehow you don't worry so much about flak and fighter attacks any more with those eggs laid. You know your training worked."

The missions of these boys began way back when they were selected for bombardment after their initial training, and got started working together as a crew. They were put together perhaps first in an advanced trainer such as the Fairchild AT-13, a plywood job with all of the facilities of the big metal combat planes.

There each learned his particular job as pilot, co-pilot, bombardier, navigator, radio man, flight engineer—and gunner. But more important than any of these, they learned that no one man could do his job well unless he was perfectly coordinated with every other man in the crew. All-star teams just thrown together cannot beat a tried and true combination on the baseball diamond, the football field, or in the air.

So they go through everything together from those first trainer operations until, in actual big bombers, they fly practice missions on vast ranges where every possible battle condition is simulated. Some of them are in the heat and dust of the southwest deserts. Others are up over the snow-capped mountains of the north. Some of them are over permanent waste lands where operations are carried on the year round. Others, simulating more closely actual battle scenes, are over sheep and cattle ranges or over wheat farms where no bombing or firing can take place while the animals are grazing or the crops growing.

But all of them are far enough away from the bomber training bases to require extensive skill to find the target area in the first place and further skill to hit it, either with guns or bombs. That is the development of a combat crew. As a unit, all of its activities must be disciplined. Yet its individual responsibilities are delegated. Each member commands,

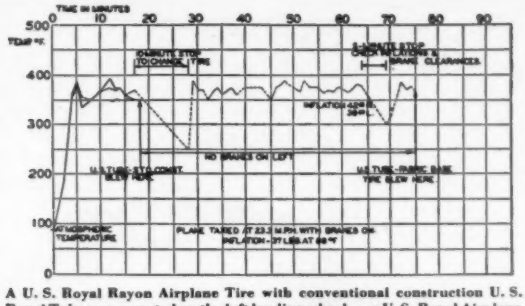
(*Continued on page 228*)

FLYING

"Wow! I guess we're just a couple of amateurs!"

HOW A NEW TYPE AIRPLANE TUBE *Solved* A BRAKE-HEAT PROBLEM

Cross-section of the "U. S." Fabric Base Tube that solved the heat problem caused by excessive braking on the Cessna Bobcat Advanced Bomber Trainer. A reinforcing cord insert across the vital bead area increased the service life of the tube 100 times.



A U. S. Royal Rayon Airplane Tire with conventional construction U. S. Royal Tube was mounted on the left landing wheel . . . a U. S. Royal Airplane Tire and "U. S." Fabric Base Tube on the right. The plane was taxied at 23.3 miles an hour with brakes applied. The chart shows what happened.

THIS WAS THE PROBLEM

It was natural for cadet pilots at the controls of the powerful, twin-engined Cessna Bobcat, landing at higher speeds than they had ever known before, to "tramp" on the brakes and keep them on even while taxiing the plane. Temperatures as high as 750° built up in no time, temperatures so high that no tube could stand up. Working with the brake manufacturers, Cessna engineers brought the temperature down to around 450°. Performance improved, but still tube failures occurred too frequently.

THIS IS THE ANSWER

A "U. S." Field Airplane Tire Engineer working with Cessna took a leaf from his experience with bus lines where high brake-drum heat is often encountered. He suggested that the "U. S." Fabric Base Tube might be the answer.

A special tube of this type was built and tested against a conventional tube under the extreme conditions shown above. The conventional tube blew out in 18 minutes. The tire equipped with the "U. S." Fabric Base Tube ran for 75 minutes . . . and then the casing failed, not because of a tube blowout, but because of carcass fatigue.

Today, when "U. S." Fabric Base Tubes are standard equipment on all new Cessna Bobcats, tube performance of 450 to 500 hours without failure is not unusual. Before, tubes often failed in less than five hours. If you are faced with a tube problem, the services of a "U. S." Field Airplane Tire Engineer are available to test a "U. S." Fabric Base Tube on your aircraft.

UNITED STATES RUBBER COMPANY

1230 Sixth Avenue • Rockefeller Center • New York, 20

Corsair...ALTITUDE

With its highly supercharged 2,000-horsepower engine, the Navy's Vought Corsair operates at extremely high altitudes. From this commanding position, Corsair pilots are pouncing on the enemy with deadly effect.

CHANCE VOUGHT AIRCRAFT
STRATFORD, CONNECTICUT
ONE OF THE FOUR DIVISIONS OF UNITED AIRCRAFT CORPORATION

A Triple Play--AGAINST THE AXIS!

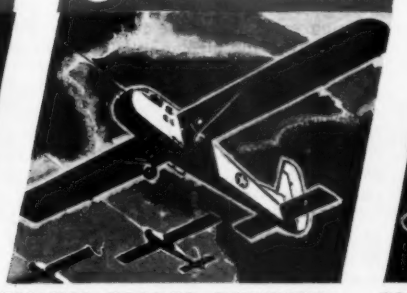
Mussolini is OUT...and soon Hitler and Hirohito will be too! Every last man and woman on our team is hitting a higher batting average each month...all three Timm Divisions are helping to put them out...for good!

1 METAL DIVISION

TIMM'S METAL DIVISION

produces metal parts and fabrications for all types of combat planes. The ones that have played such an important part in putting Mussolini out!

2 GLIDER DIVISION



TIMM'S GLIDER DIVISION

is the only West Coast producer of the giant Army Troop Transport Glider, the CG4A, capable of transporting a Jeep and four fully equipped soldiers or their equal; you're out next, Hitler!

3 AIRCRAFT DIVISION

TIMM'S AIRCRAFT DIVISION

is busy producing the Timm Aeromold Tutor, N2T-1, for the U. S. Navy. In it, Navy and Marine flyers get their first instruction...Hirohito, you're the third out!

Timm

TIMM AIRCRAFT CORPORATION
LOS ANGELES 14, CALIFORNIA

TIMM AEROMOLD

(*Continued from page* 224)

but all are subject to obedience. The group is what counts.

The pilot and co-pilot fly the ship. But they take their directions from the navigator. For he alone knows how to reach the objective. Arriving at the target, the bombardier takes command. It is his "bombs away!" which determines success or failure of the mission. The radio operator is the voice and ears of the plane. It is he who establishes contact with its squadron, its base. Throughout the flight it is the engineer who watches over the engines, listening for the slightest indication of failure. Upon the aerial gunners rests the responsibility for the defense of the plane and the safety of its crew. The sharpness of their eyes, the coolness of their judgment, the accuracy of their gunnery, will determine in no small measure whether ship and men return to their base alive.

But mere understanding of the mechanical problem of the other members still will not produce a bomber crew. The peculiar chemistry of personality must blend and fuse. They must have implicit confidence in each other. When life depends upon split-second timing, each member of the crew must know (without ever having to give it conscious thought) what he may expect from every other man on board. Precision bombing involves something more than the employment of a remarkable bombsight, or even the correct application of strategic aerial principles of warfare. It is all this and something more. It is the realization that a bomber crew is not an improvised assembly of technicians.

It takes three months to whip a heavy bombardment crew to the standards of proficiency required for combat duty. The training of the Army Air Forces heavy bombardment crews rests with the Second Air Force under the command of Maj. Gen. Davenport Johnson.

The training is divided into three phases. During the first phase of training, the individual technicians—the pilot, co-pilot, navigator and bombardier (commissioned officers), the flight engineer, radio operator and the aerial gunners (generally non-commissioned officers)—are assigned as the respective members of a crew. Under the close observation of the commanding officer, "personality kinks," if any, are quickly ironed out. The individual training of the crew members is continued. They become familiar with their equipment and each other. During this period, the individual crews are watched over by a parent group composed of experienced flight and ground personnel whose experience (constantly being enlarged through returned combat crews) is utilized for instructional purposes.

At the end of the first month, the recently formed crew is ready to start "on its own." It leaves its parent group and departs to a new base. For the first time the crew—now part of a new group—is joined by its own ground and administrative echelons. Key personnel, who have received specialized training at the Army Air Forces School of Applied Tactics, also join the newly-formed groups. For the first time, the individual crews meet their squadron commanders.

Now the training of crews as combat teams commences in earnest; operational teamwork among crews as flights, squadrons and groups is undertaken. During this second phase of training the crew will fly "model missions," each progressively more difficult, some by day—others by night. A typical mission of a three-plane day flight formation with the general duties expected of the combat crew follows:

"Individual take-off, defensive formation, formation air-to-ground gunnery, triangular navigation, medium-altitude formation combine, separate instrument approaches.

"GENERAL DUTIES OF COMBAT CREWS: *Pilot:* Take-off will be by separate airplane. Assemble over airdrome at 1,000 feet. Formation will proceed to aerial gunnery range where firing will be conducted in formation, controlling the formation to obtain the maximum firing power towards the target. From the gunnery range a triangular navigation problem will be flown—each leg 100 miles, last leg to the bombing range. Each airplane will lead one leg of navigation problem. Bombing will be done from 14,000 feet, using evasive maneuver on approach to bombing run. Lead will change to allow each airplane to lead one run. Formation will proceed from bombing range to local radio range station where airplanes will stack up over station at 1,000 feet intervals where pilots will execute holding procedures. Control tower or radio range station will co-operate to simulate congested traffic being handled by Airways Traffic Control. All personnel will be at battle stations throughout the mission except the lower turret gunner who will take station after take-off.

"*Co-pilot:* Assist the pilot, particularly during the instrument let-down and through each leg of the formation. Co-pilot will fly the airplane at least half of the time, except during let-down.

"*Navigator:* The navigator of the lead ship on each leg of the triangular navigation problem will use DR (dead reckoning). Navigators in wing airplanes will follow the pilot. Use radio bearings and check follow-the-pilot position.

"*Bombardier:* Each airplane will carry at least seven bombs. Bombardier fires 25 rounds nose gun at gunnery range. Assist navigator during the navigation problem. Bombing from 14,000 feet—bombardier in lead airplane, sighting for range and deflection, will drop five bombs in train. Bombardiers in wing airplanes will sight for range only and will drop only one bomb. Space of train will be in such intervals to cover area desired on the target. Evasive maneuver will be used in each bombing run approach.

"*Engineers:* Fire battle and alternate stations at the gunnery range. Maintain engineer report. Will follow course on sectional chart. Will lower landing gear manually for landing. Check Form 1A with maintenance crew.

"*Radio Operators:* Gain and maintain contact with ground station. Send position reports every 30 minutes or by prearranged schedule, while acting as lead airplane of the formation. Radio operators in wing airplanes will stand by to receive. Fire battle and alternate gun stations.

"*Turret Gunners:* Track other airplanes, clouds or shadows. Fire battle stations at gunnery range.

"*Gunners:* Will follow course on sectional map. Fire battle and alternate stations. Tail gunner—spot bombs and check with bombardier."

The third phase of training is designed to put the finishing touches on the group as a whole. Now the group receives training in flying long missions involving overwater flights as well as training in current tactical problems. As nearly as is possible combat conditions are simulated. The crews are alerted. Prior to each mission they are briefed by the squadron commander or the intelligence officer. The target is announced. The approach to the target is suggested. Particulars, based on the "opposition map," are given as to what "enemy" defenses may be encountered—fighter opposition, antiaircraft guns and balloon barrages. The bombardiers are issued their target maps. Meteorological conditions to be encountered on the mission are presented. Upon completion of the mission, the crew will be interrogated.

There no longer is an atmosphere of "make-believe" surrounding the training flights. For each crew member knows that the end of the three months' training period is in sight. Each crew knows that before long the briefing may take place on an airport of the Eighth Bomber Command somewhere in England. Before long, they will play for keeps.

They do automatically the things which have come so laboriously during the long, arduous months of training. These crews are working crews now. They know their jobs. They know each other. They know their ships. Each crew has christened its own plane with a special name, which seems to breathe life and individuality into that great mass of aluminum, instruments, wiring and driving power; a name which transforms their plane into a warm, vibrant personality. "Bomb Boogie," "Axis Nightmare," "Eager Beaver," "D-for-Dog"—John Steinbeck has called it the best writing of the war. The American public has become familiar with these nicknamed bombers through the return to this country of such famous planes as the "Memphis Belle" and many others similarly "personalized."

During these final weeks, the whole tempo of training becomes accelerated. The squadron C.O. is critical of anything short of perfect bombing. Everything now is pyramided to the day of departure—the real mission. And it is for this day, this mission, that the most thorough operational training yet designed by any Air Force has been given to the heavy bombardment crews of the AAF.

And back of those months of training lie the years of development of the American big bomber—at Wright Field and in the factories—that enable these trained crews to fly the missions which are adding the decisive third dimension which will win the war. END

POLICE POWER FOR *Peace* . . .

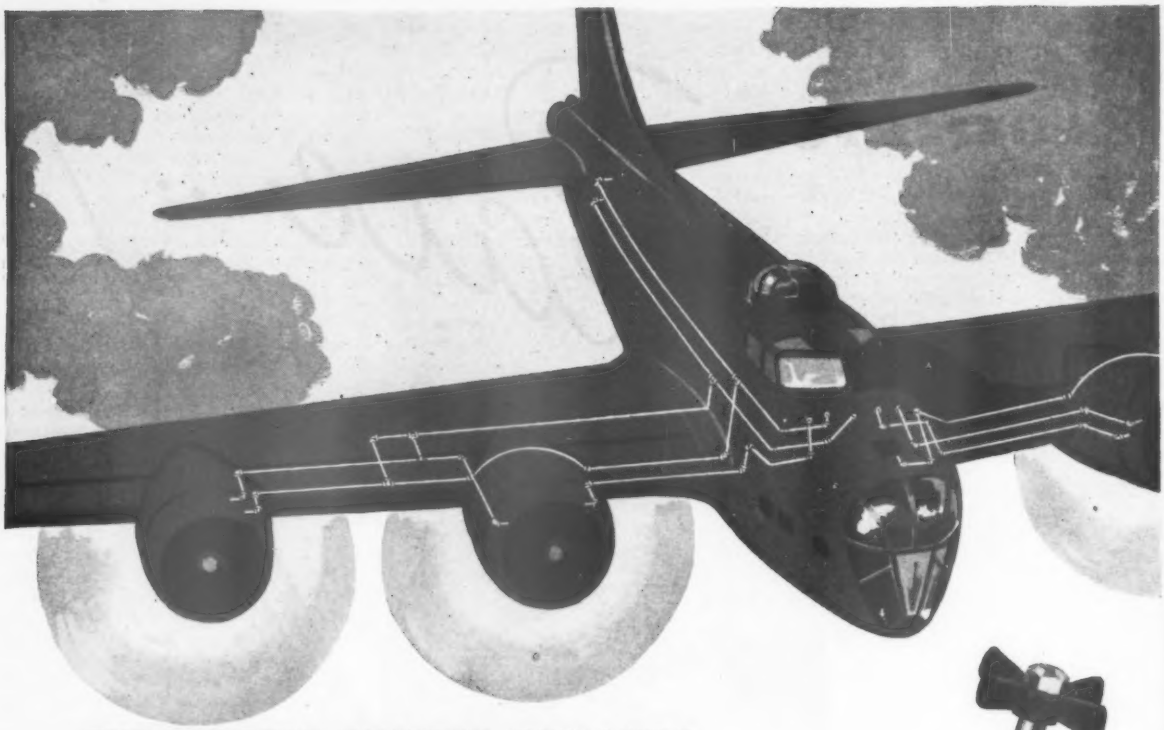
Down the sea of centuries man has sailed the ship of his dreams in pursuit of the pathway to peace. Perhaps his dreams may soon bear fruit. For the hope of a police power for world peace may yet become a reality at the close of the present conflict. In the struggle for the attainment of that aim, America pays tribute to the tireless efforts of every man and woman engaged in aircraft. For it is THEY who produce the power so essential to police the future peace.

ROMEC PUMP COMPANY • ELYRIA, OHIO, U. S. A.

Manufacturers of Aircraft Pumps and Accessories

FIRST IN DEPENDABILITY **Romec**

BUY WAR BONDS



THE BIGGEST BOMBER DEMANDS

DEPENDABILITY

IN ITS SMALLEST PART

● Just as the whole is the sum of its parts, the quality of the whole airplane—the stamina, the strength, the battle superiority—is determined by the *quality* of small parts like Dole Aircraft Valves & Fittings.

This fact is recognized by every workman, woman, engineer, inspector and executive in Dole's plants and offices . . . and shows up in the product as uniform dependability.

THE DOLE VALVE COMPANY
Established 1906
1901-1941 Carroll Avenue, Chicago, Illinois
Los Angeles • Detroit • Philadelphia

DOLE

★ Made in Accordance with Army-Navy Aeronautical Standards ★

AIRCRAFT VALVES AND FITTINGS

Veterans of *Every* Battlesky

No other American-built fighters have fought so many battles, have downed so many enemy planes—over mountain, jungle, desert and sea—from the bleak Arctic to the blistering tropics—as have the Curtiss pursuits, veterans of the battleskies of World War II.

CURTISS-WRIGHT
Corporation
AIRPLANE DIVISION
BUFFALO • COLUMBUS • ST. LOUIS • LOUISVILLE

Member: Aircraft War Production Council, East Coast, Inc.

FIRST
Since The Birth of Aviation

CURTISS WARHAWK
LATEST OF A LINE OF FIGHTING HAWKS

It's Okay, Mom

We have this to say . . . to a lady whose boy has gone to war. All of us here in America want our fighting men to come back.

To help bring them safely home, we're giving them the best equipment we can produce. The finest of food, clothing, medicine, guns, tanks, planes.

That's why planes like the U. S. Army Bell Airacobra are designed with stout armorplate protecting the pilot . . . With self sealing gas tanks . . . With bullet-resistant "armor glass" . . . With a 37 mm. cannon in the nose. (After all, an explosive cannon shell hurtling at the enemy is a pretty good protective device!)

These and all the other safety features built into American planes add weight, make design problems tougher. But they'll bring safely home many an American boy who might not have come home without them.

WHEN they come home, they'll want planes of peace. There'll be another era of aircraft pioneering—this time to make planes still safer, simpler, more useful, more economical. You'll see then how an aircraft manufacturer could pack decades of aviation progress into a few short years of war. © Bell Aircraft Corporation, Buffalo and Niagara Falls, New York.

BELL *Aircraft*

AIRACOBRAS for victory—future planes for peace

The Fighter

(*Continued from page* 134)

An ordinary engine at 30,000 feet produces only one-third of its rated sea-level horsepower.

We overcome this in an aircraft engine by supplying three times as much air (measured by volume) to the engine, giving sea level density and thus sea level horsepower. To do this, we must use the turbo-supercharger.

When we add a supercharger to an airplane we increase the weight and change every other factor of performance at various altitudes. Increasing the weight lengthens the take-off run, cuts down maneuverability, and slows rate of climb. High speed is usually decreased when weight is increased.

Thus an airplane designed for high altitude performance would not be as efficient at low altitudes as an identical airplane with the same engine less supercharger. In other words, a high altitude fighter would be carrying additional weight at low altitudes from which it is receiving relatively little benefit, thereby adversely affecting its customary performance.

A number of basic requirements in fighter design affect its performance. The special service for which our fighter is to be used is the determining factor. Since no single design can be superior in all characteristics, we must build several fighters for high and low altitudes, each with specialties—range, speed, firepower. We should be cautious in comparing our fighters with enemy aircraft. We must consider *all* the characteristics of each of our fighters with those of each different type of enemy aircraft.

For example, compare the Japanese Zero with our own *Warhawk*. The Zero is light in weight, is more maneuverable under 300 m.p.h., has a higher rate of climb than the *Warhawk*. On the other hand, the *Warhawk* has more speed and can dive faster than the Zero. The firepower of the *Warhawk* is superior. The Japanese sacrifice armor protection and self-sealing fuel tanks in the Zero in order to decrease the weight, thereby gaining maneuverability and a higher rate of climb. The Zero, when hit with .50-caliber bullets, will literally explode in the air, whereas the *Warhawk* will absorb a terrific amount of fire and still be able to fly home.

True to their creed, *Warhawk* pilots attack and attack the Zero. But they play by the rules:

They never attempt to dogfight the Zero.

They never maneuver with the Zero at speeds below 300 m.p.h. indicated.

They never follow a Zero in a climb at slow speeds.

Many fighter pilots, coming back from the theaters of operation, are being assigned to commands for the purpose of training groups and squadrons being activated for overseas assignment, to make available to these units the experiences they have gained in combat. END

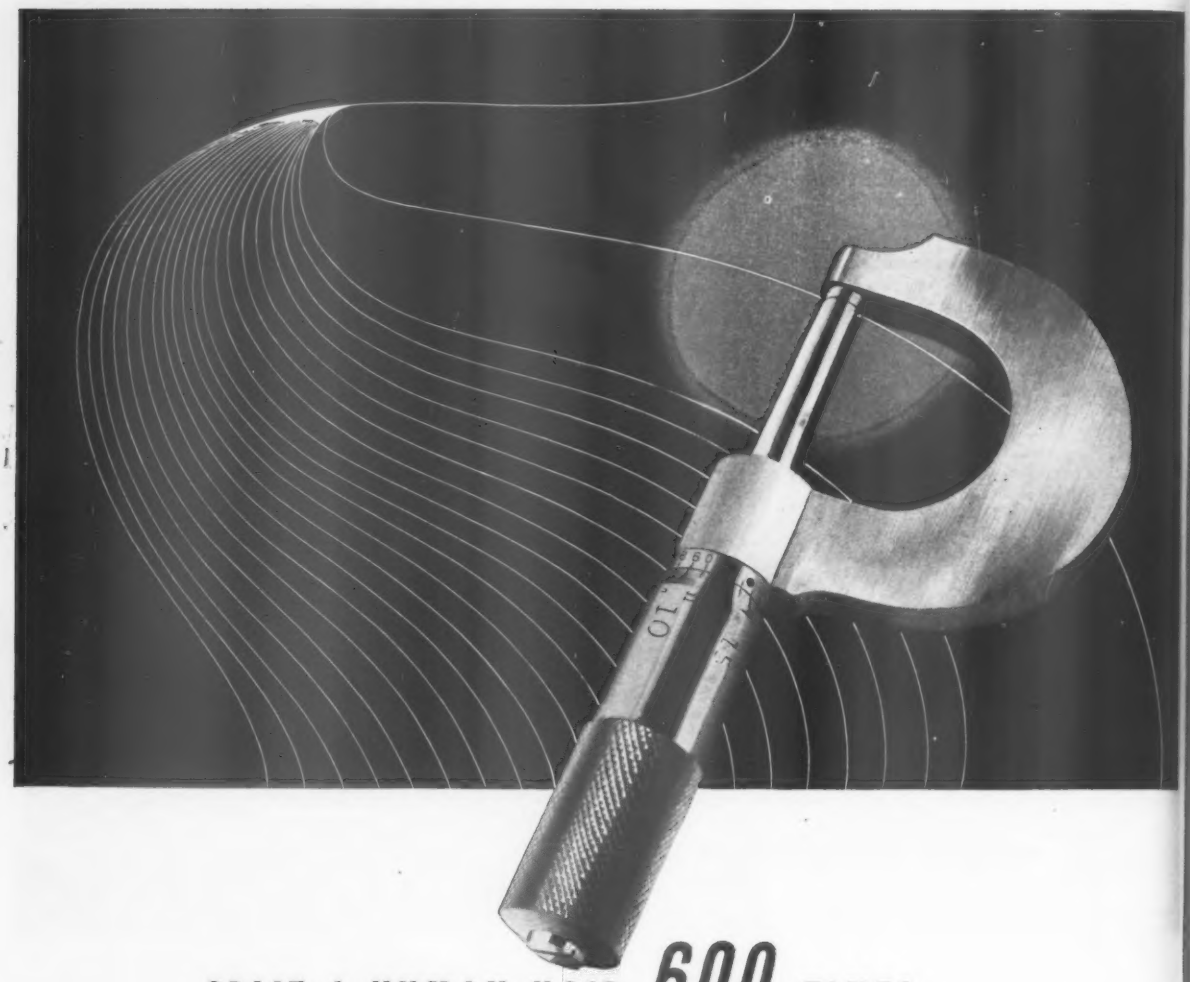
"...and carry a big stick"

They are. They're carrying sticks of bombs big enough and strong enough to splatter their targets to kingdom come. And they're driving them deep into the heart of the Axis; stabbing through the hard shell of flak into tender industrial areas where they hurt most.

It's partly because we ride the sky artillery too. Standard of California's high octane gasoline is giving bomber motors the muscle it takes to lift the biggest block busters. And it's shrinking fuel consumption, so United Nation's planes can fly faster, drive deeper into enemy territory.

These super fuels are going into fighting planes now. But before long the magic of Standard Aviation Gasoline will be cutting fuel loads, boosting pay loads on commercial sky giants. Engines will be lighter, but they'll turn out more power. Planes will be faster, but burn less fuel. For finer motors and bigger planes, there'll be even better Standard Aviation Fuels and Lubricants — to put the power into post-war aviation.

STANDARD OF CALIFORNIA



SPLIT A HUMAN HAIR 600 TIMES

That is five millionths of one inch. An infinitesimal dimension . . . a dimension that's part and parcel of every working day at Schrillo . . . a language that is spoken fluently by our craftsmen. For it's not unusual in this plant to work to .000005" tolerances in the manufacture of Schrillo Precision Products. The industries we serve require it —Schrillo scientific laboratory control assures it.

Schrillo Pipe Plugs and Ring Gauges are examples of the meticulous care taken in the manufacture of our products. The unsurpassed accuracy of these gauges is reflected in the increased speed of today's production line operations. For gauges serve not only to determine accuracy of dimensions—they prove the identity of production assembly duplications, assuring perfect interchangeability of parts.

The complete Schrillo line embodies extreme precision of design and manufacture. It includes Thread, Plug, Ring and Special Gauges; Taps, Counterbores, Cutters, Countersinks, Spot Facers, Angle Drives. Specify Schrillo when perfection is essential.

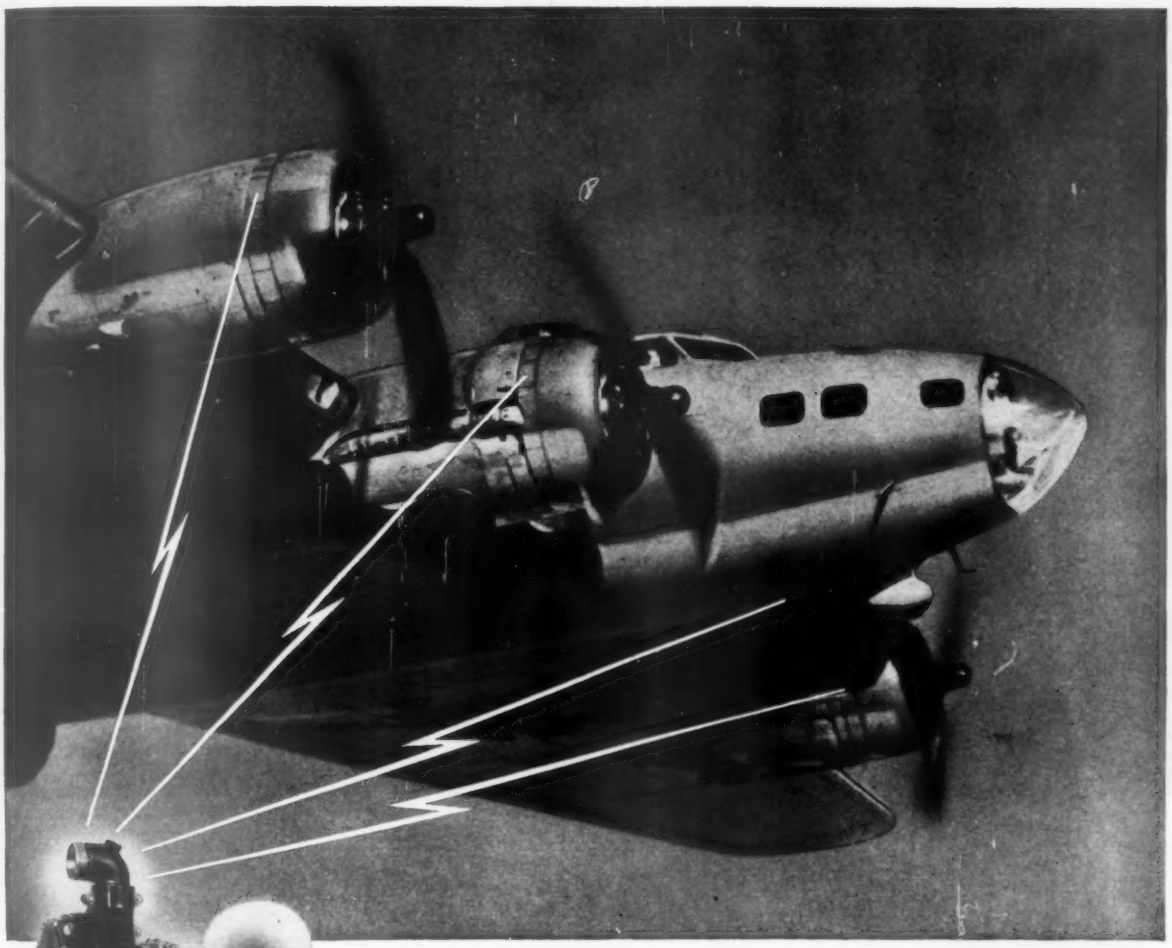
"Tools are weapons—treat 'em right!"

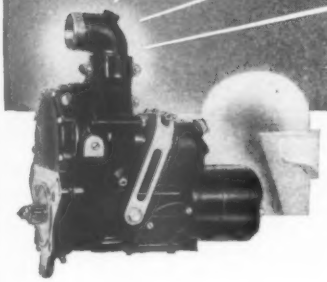
Schrillo Aero Tool Engineering Co.
8715 Melrose Ave., Los Angeles 46, Calif.

SCHRILLO

LOS ANGELES CALIFORNIA

PIPE PLUGS AND RING GAUGES BY SCHRILLO





SPARKS OF LIFE
for the Queen of the Skies

HIGH out of reach of thundering enemy ack-ack, the Boeing Flying Fortress carries out her allotted task. One thing that enables her to fly at such high altitude is Bendix-Scintilla* Aircraft Ignition.

This precision-engineered equipment must generate, control and deliver *every minute* 40,000 sparks to each engine . . . timed to the split second! That calls for *precision* ignition . . . as engineered by Scintilla.

Engineering Bendix-Scintilla Aircraft Magnetos, Harnesses and Switches to their present high-altitude performance has constituted a series of major accomplishments in aircraft ignition design.

Today, these accomplishments are contributing importantly to the strength of wartime Air Power. Tomorrow, they will just as surely aid the progress of peacetime Air Transportation.

Bendix-Scintilla Aircraft Magnetos, Harnesses and Switches are vital members of "The Invisible Crew"— precision equipment which 25 Bendix plants from coast to coast are speeding to our fighting crews everywhere.

THE INVISIBLE CREW
Precision Equipment by Bendix
AVIATION CORPORATION

*Trade Mark of Bendix Aviation Corporation.

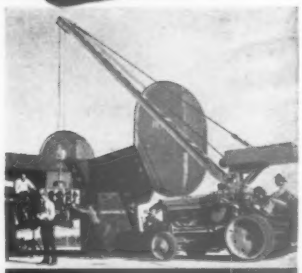
SCINTILLA MAGNETO DIVISION BENDIX SCINTILLA THE WORLD'S FINEST AIRCRAFT IGNITION

Catalina Navy Patrol Bomber on Anti-Japanese Patrol. Official U. S. Marine Corps Photo

Free-Roving Tractor-Footed ROUSTABOUT CRANES

SPEED HANDLING

of War Materiel, where it's made, where it's used



● Around war-busy airfields and airports, factories, railroads, docks and warehouses you'll find increasing hundreds of these powerful load-handlers hustling bulky stuff for Victory. On wheels or crawler tracks, Roustabout Crane is *where* you want it *when* you want it—preventing delays, loading, unloading, stacking anything to 5 tons. Easy to operate, all tractor power, ball-bearing boom turntable, gears in oil—built for years of punishing work. Our production now goes to American Fighting Forces, war plants and transport services—for fast action now, for post-war cost cutting, write for the facts today about Roustabout Cranes.

Full boom swing aids loading of transports and handling aircraft parts.

THE HUGHES-KEENAN CO.
607 Newman Street, Mansfield, Ohio

ROUSTABOUT CRANES
By Hughes-Keenan

Load-Handling Specialists Since 1904

The Men

(*Continued from page* 115)

Forces must promote morale—without calling it that.

Today's Army sees it in terms of Martha Raye on the African front, movies on Guadalcanal, baby juke boxes in Iceland. A greatly expanded Special Service Division uses radio, films, Broadway stars and streamlined sports programs to mold civilians into fighters with guts.

As the Army Air Forces sprawled across the globe, Special Service personnel and equipment brought Main Street and Hollywood and Madison Square Garden to the desert, the jungle, the polar ice-cap. Bulwarking Special Service are the Corps of Chaplains, the American Red Cross, the USO at home and abroad.

But "morale," as every soldier knows, mostly means news from the home folks, from the girl in the tattered picture, from the gang at the plant. Letters, like weapons, help "keep 'em flying." Some of war's most dangerous missions have brought mail to Bataan and Guadalcanal.

Today's Air Forces man is the typical American of 1943. He scoffs at heroics—and fights to the death. War Department files bulge with legends of bravery beyond the call of duty.

It is the responsibility of Personnel to recognize gallant action with the award of appropriate citations and medals. It is hard to choose heroes. Every man in action knows that distinguished service is an AAF tradition.

The enormous expansion of the Air Forces never could have produced more than a hodge-podge of individuals if classification and reclassification had not been done efficiently.

To spot the right man in the right job, AAF policy does not:

1. Treat human material lightly because there seems to be plenty of manpower.
2. Hold back a good man from advancement because he is "irreplaceable."
3. Keep a misfit in a job just because it's the "easier way."

On the other hand AAF policy does:

1. Try to place a man in the most valuable job for which he's fitted.
2. Put the power to classify and reclassify in the hands of trained personnel officers.
3. Promote men on the basis of ability, not formula.
4. Educate men for better jobs through the technical training program.

There are no hard and fast rules except that a trained, efficient man in the right job helps make the AAF the fighting team it is.

Like all great teams, the Army Air Forces has been gifted with excellent leadership. The names of Arnold, Chennault, Doolittle, Bissell, Kenney, Brereton, Eaker, Spaatz and others on the "top side" are examples. To give us air power, this band of flying generals has forged weapons from planes and guns and vision—and the fighting heart of America's kids across the street.

"O BRAVE NEW WORLD..."

The shortest distance between two points is . . . a curved line across the top of the world! Short cut sky lanes to Bombay, Chungking, Moscow, Tokio, Sydney, Cape Town rise high above vast seas of glittering, icy wastes. Sky lanes—now being charted by the post-war planners of America. Sky lanes that bring our very farthest neighbor to us in no more than 60 hours.

Tomorrow's new world lies in the palms of the draftsmen of today. They are linking country to country, continent to continent. And in this tremendous project, as in every other important blueprinting work, *Typhonite* ELDORADOS lead all other drawing pencils with their decisive clarity, uniform degrees, opacity and speed. *Typhonite* ELDORADOS are helping to plot our brave new world.

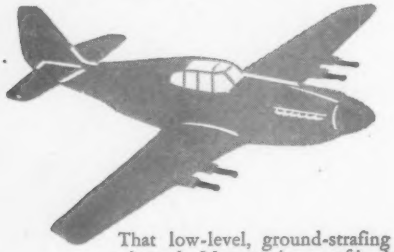
✢ ✢ ✢

** The new booklet describing the* Typhonite *process is offered to draftsmen. Write for your copy mentioning this publication.*

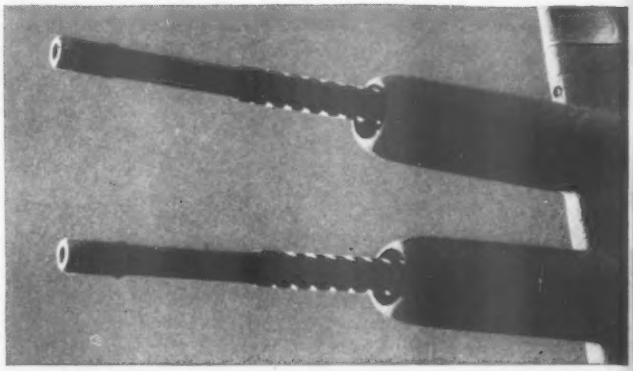
Pencil Sales Dept. **64-J10,** Joseph Dixon Crucible Company, Jersey City, N. J.

Sluggers of the Sky!

THE *MUSTANG*

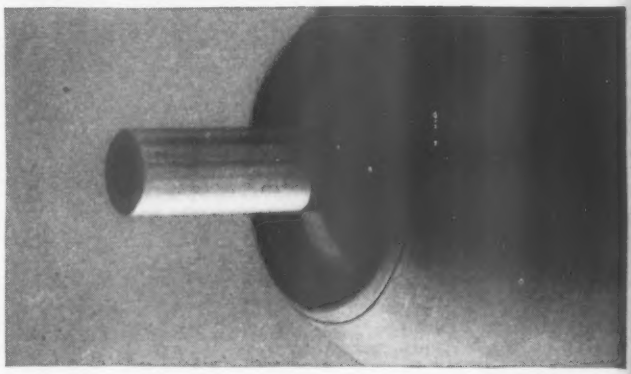


That low-level, ground-strafing attack plane, the Mustang, in one of its deadliest versions, packs the fire-power of four 20 mm. automatic cannon, two in each wing.



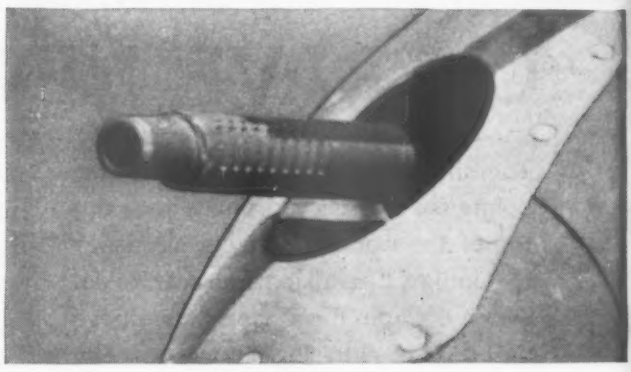
THE *COBRA*

The "flying cannon" Airacobra was designed around its fire-power. A unique engine-in-the-rear construction leaves room for a 37 mm. cannon in the nose.



THE *LIGHTNING*

The versatile Lightning, which has compiled outstanding combat records on every front, also carries a hard-hitting 20 mm. cannon, in the nose for easy aiming.



ALL PACK THE PUNCH OF CANNON

★★★★★★★★★★★★★★★★★★★★★★★★

Keep 'Em Flying . . . Keep 'Em Firing

BUY WAR BONDS!

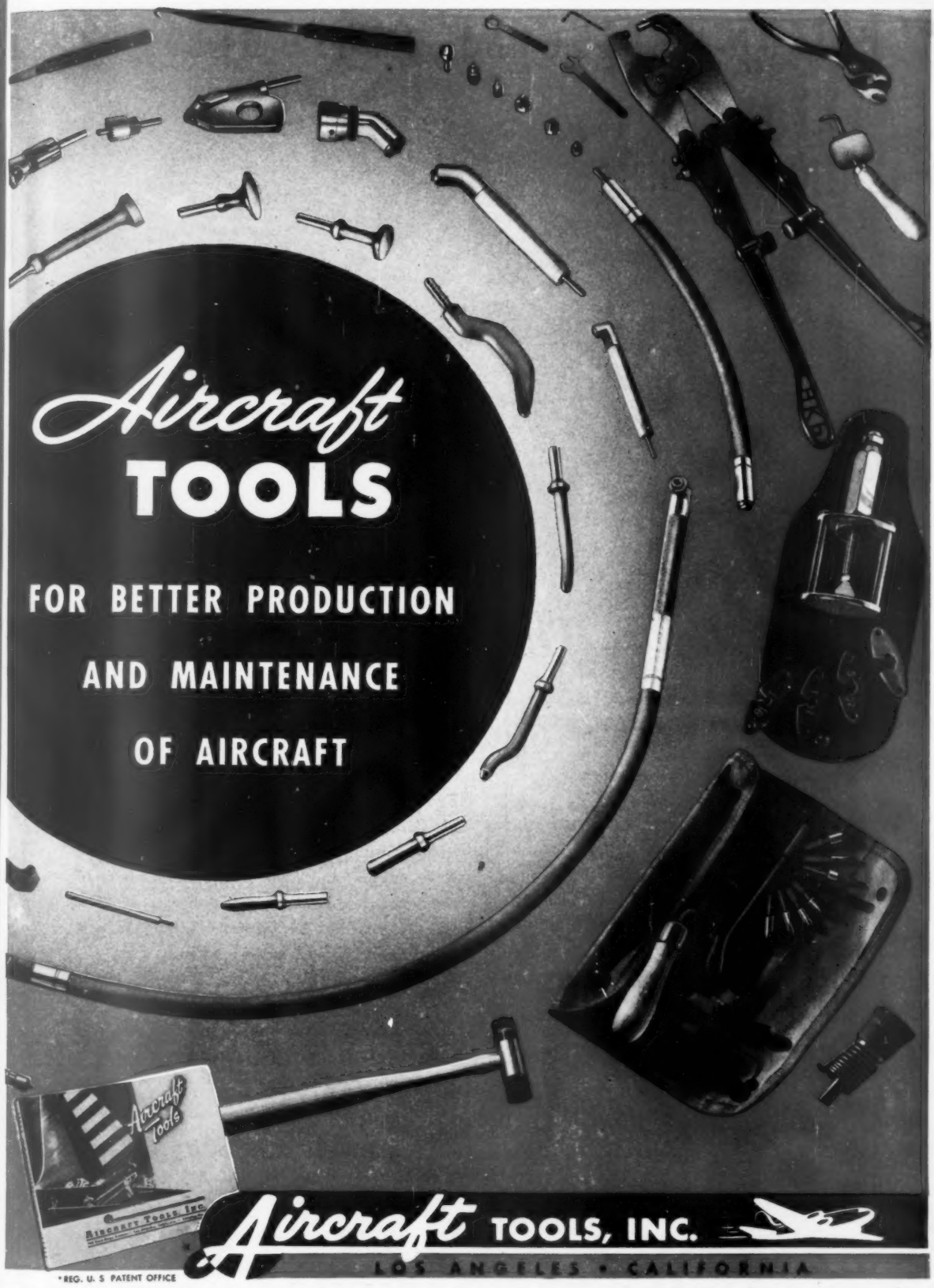
The 3rd War Loan is under way! Think of the boys you know who are fighting for *you* overseas. You can help them by supporting this drive to the very best of your ability. *Back the Attack with War Bonds—Extra War Bonds!*

★★★★★★★★★★★★★★★★★★★★★★★★

Three great fighters . . . and in all three cases, part of their greatness is due to their *fire-power.* For these, like the famous British Spitfire and Hurricane, are cannon-firing planes. And automatic cannon are truly the "right hooks" of aerial warfare. They provide the punch to knock out any plane that flies, stop a tank, or even sink a ship! . . . Oldsmobile is privileged to build these automatic cannon for America and her Allies. Also to produce high-velocity tank and tank-destroyer cannon—high-explosive and armor-piercing shell. FIRE-POWER IS OUR BUSINESS!

OLDSMOBILE DIVISION OF **GENERAL MOTORS**

KEEP 'EM FIRING



*REG. U. S PATENT OFFICE

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AVIATION'S BIGGEST CUSTOMER LIVES IN WASHINGTON, D.C.

. . . And Reads The Washington Post

Government is the biggest single customer of American business today—and tomorrow, too.

Government is a peculiar customer.

It's hard to know whom to see about getting the order. And maybe yesterday's contact isn't tomorrow's.

Lots of officials put their fingers into the purchasing pie when government is the customer. That means lots of officials to sell on your product.

Government is a fussy, suspicious customer, too. Butts into your labor policies, your methods of doing business, your profits, your ideas for the future. Needs to be reassured on points that ordinary customers don't consider any of their business.

But since government lives in Washington and reads The Washington Post every morning it isn't too hard to get your story across to all those concerned at the same time. To the President, for example, and every member of his Cabinet, and 98% of the heads of the war agencies, and 72% of Washington Army and Navy officers, and almost all the members of the Senate and House of Representatives. The Washington Post has coverage where business most needs to make an impression.

The Washington Post's definite leadership in advertising directed straight to government indicates that American business is learning the importance of keeping its best customer sold.

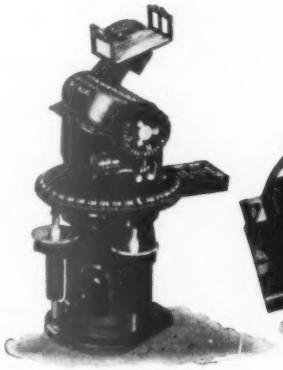
The Washington Post's rate is $732 a page; a twelve-page campaign costs less than $9,000.

The Washington Post

Eugene Meyer, Editor & Publisher

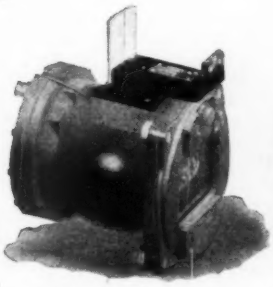
Represented by Osborn, Scolaro, Meeker & Co., New York, Chicago, Detroit, St. Louis; by George S. Close, Inc., San Francisco, Seattle, Los Angeles; and by Metropolitan Sunday Newspapers for Sunday Comics Advertising.

These are products made by our company for war-time aircraft. Because they are typical of American enterprise and engineering they are well-made, precise, and highly useful to the Armed Services.

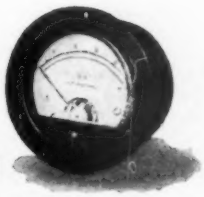


ASTRO COMPASS

BOMB RELEASE SWITCHES



COMPASS SWINGING SIGHT



ELECTRICAL INDICATING INSTRUMENTS

BUT...

Let's take that for granted. Why shouldn't we be able to produce fine weapons in a nation that's filled with good materials, splendid machinery, skilled hands, and fine minds?

The question is—have each of us the spirit that goes a long step beyond mere manufacture—the spirit to build weapons and then *pay for them* with our purchases of war bonds?

That's the measure of our patriotism.

To *build* for Victory is our duty as manufacturers.

To *save* for Victory is our responsibility as *citizens*.

The W.W. **BOES** *Company, Dayton, Ohio*

MANUFACTURERS OF ELECTRICAL AND NAVIGATIONAL INSTRUMENTS FOR AIRCRAFT

The Birdmen's Perch

We're in love!

Lately we've done a heap of traveling. The Gulfhawk has left tireprints on Army runways all over the country. And that's where we met this dream girl—at Army airports.

She's wonderful! . . . and her name is WAC.

At some busy Service fields she was in the tower and got us in with such crisp efficiency that we felt like the only plane in the area. At other fields she did the weather work—and when she said our destination would be "open" at our ETA, it *was* open. And once she fixed a sick oil pressure gauge in almost less time than it takes to write about it!

We knew that our dream girl was releasing men for combat duty. But at one base, the CO told us that on some jobs a Wac replaced *two or three men!*

We're awfully proud of our girl. And if you've a sister or daughter who wants to give a hand to winning the war, take our word for it, pilot—*she can't beat the WAC!*

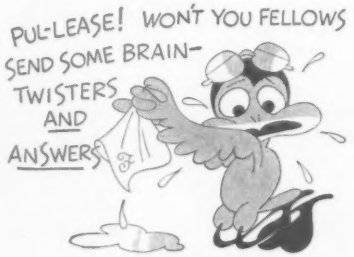
Major Al Williams,
alias, "Tattered Wing Tips," Gulf Aviation Products Manager, Gulf Bldg., Pittsburgh, Pa.

HE DIDN'T USE RADIO, EITHER—

When the only clock in his house (and the only timepiece he owned) ran down, a certain Perch Pilot didn't even say, "Pshaw." For Perch Pilots are made of Stern Stuff and have Pure Hearts to boot!

Instead, this bucko walked out to the local airport, sat around "flying the chair" a while, and returned home—where he set his clock correctly! Can you tell how?

We can. We will, in fact, if you ask us!



ABOUT EARDRUMS AND OILDRUMS

Have you ever asked ATC for approval of a flight plan change and heard this reply:

"CRASH ! ! ! ‡*?&*& BOOM ! ! TO CRUISE AT BANG!! CRACKLE #&** # GO AHEAD" . . .

Well, there's a gadget called the "radio static neutralizer" which private pilots will be able to get after the war (military fliers are getting them now) that eliminates static electricity from your reception . . . actually putting it to useful work.

We're not allowed to describe this "eliminator" very clearly—we can only tell you what it does. But we *can* tell you plenty about another "eliminator" . . . the Alchlor Process.

That's the method we use in refining Gulfpride Motor Oil, the world's finest motor oil. In effect, the Alchlor Process is an *extra* refining step which eliminates *more* of the carbon-making and sludge-forming molecules, and actually rearranges other molecules in Gulfpride to make them do more work.

Understand?

TNT FOR TWO

A war ago, nearly all the toluene (that's the last "T" in TNT) used in explosives came from the coal-tar industry.

But today a greater portion of the toluene for ordnance centers comes from the nation's oil refineries. And recently, Gulf put a brand-new unit into the production of toluene at the request of the Army Ordnance Dept.

This new unit, strategically located on the eastern seaboard, was constructed 100% with Gulf funds, too.

In short, Gulf has now gone into the business of making pre-fabricated bomb-holes for Berlin and Tokyo!

Gulf Oil Corporation and Gulf Refining Company...makers of

GULF AVIATION PRODUCTS

OIL IS AMMUNITION—USE IT WISELY

AN INACTIVE ENGINE COOLS QUICKLY IN FLIGHT—WHEN RESTARTING ENGINE IN FLIGHT,
WARM IT THOROUGHLY WITH THROTTLE ALMOST CLOSED BEFORE CRACKING THROTTLE OPEN···
KOFF!
JUST AS YOU WOULD ON THE GROUND-AND BE SURE YOU WARM UP-(AND OPERATE)-
WITH NOTHING BUT THAT GOOD GULF AVIATION GASOLINE!

SCR-299

VANGUARD OF INVASION!

THE SCR-299 Mobile Radio Communications unit played a great part in the invasion of Africa and Sicily . . . these units were used as mobile radio stations, transmitting voice commands to fast moving armored units while in action, or as permanent radio stations . . . even under the most difficult operating conditions.

A leading military authority said, "My observations in the theatres of war make it possible to say that the SCR-299 hit the jack pot in the mobile radio field as has the jeep in transportation."

BUY MORE BONDS!

the hallicrafters co.

CHICAGO, U.S.A.

THE WORLD'S LARGEST EXCLUSIVE MANUFACTURER OF SHORT WAVE RADIO COMMUNICATIONS EQUIPMENT

The Training Command

(Continued from page 157)

mathematics, physics, code, weather and military courtesy also occupy prominent spots in the curriculum. On completion of the course, graduates are qualified for non-combatant flying duty with the Air Forces, principally in the ferrying division of the Air Transport Command. Jacqueline Cochran, noted woman flyer, is in Washington as director of the program. The training school is in operation at Sweetwater, Tex.

Concluded only recently, the training of men for the Royal Air Force provided invaluable assistance at a time when it was most needed by Great Britain. In the interval during which thousands of youths from England, Scotland and Australia won their wings on foreign soil, the facilities necessary for returning training activities to United Kingdom possessions have been completed.

However, training continues for refugee eaglets from Holland and the Dutch East Indies who will return to action under the colors of their homeland. Although supervision is provided by the Training Command, operations are directed by Dutch officer personnel at the Royal Netherlands Military Flying School at Jackson, Miss. Fighting pilots for one of our staunchest allies, China, are being trained in large numbers in Arizona. Their training is complete, beginning with pre-flight, and continuing through elementary, basic, advanced (both single-engined and twin-engined) and including the final preparation in light and medium bomber operational training units. When these eager sky fighters leave our shores they will be ready and anxious to encounter the foe.

While their numbers are not so great, the nation's Pan American neighbors also have shared the benefits of the Training Command's program. Schools in the United States have provided instruction for youths from more than a dozen countries of Central and South America. Training of several hundred French students is about to begin.

Link Trainer instructors are taught the maintenance and repair of all unit assemblies, the principles of control linkages and instrument control mechanics, radio aids to navigation, certain fundamentals of meteorology, a working knowledge of air regulations, civil and military—in short, all the multitude of details necessary to qualify them as men who can teach other men to perform the operations they have learned.

Technical Training

At Knollwood Field, N. C., the very fashionable Pine Needles Inn was the headquarters for a vast system of technical schools, training detachments and basic training centers that span the nation. Now personnel of the former Technical Training Command have moved to Fort Worth as part of the combined command headquarters.

Few orders emanate from Knollwood. Policies, for the most part, guide all the installations through five district headquarters at Greensboro, N. C.; St. Louis, Mo.; Tulsa, Okla.; Denver, Colo.; and Miami Beach, Fla. A general officer with staff commands each district headquarters, hub of technical training activities for all posts, camps, stations and detachments within its area.

When war broke out, the people handed American industry a rush order for planes. The Air Forces began to train thousands of pilots. Then America discovered she must train many times more men to keep them flying. For this, the Technical Training Command was created.

Even before Pearl Harbor, huge new air mechanics schools and replacement training centers had opened at Keesler Field, Miss., and Sheppard Field, Tex. More civilian schools signed up. Sites for new training centers were bought or borrowed, coast to coast.

Technical Training Command created a "production line" for the training of skilled technicians. Raw material from factories, farms, cities, from the homes and shops and skyscrapers of America, was started at recruit replacement centers, where processing begins. If classification picks the recruit for Army Air Forces, he is sent to a basic training center of the command.

In the basic training center two big jobs are done. First, aptitude tests, trade tests, demonstrations and interviews assign the recruit to one of the technical schools. Then, before proceeding to technical school, he gets eight weeks of basic training covering physical examinations and blood typing, orientation, pre-training, processing, drill and physical and military training.

After basic training the soldier is transferred to a technical school. He gets weeks of intensive technical training, and is graduated as a skilled specialist ready for more training or direct assignment to a tactical organization. If a student is qualified for flexible gunnery training, he will proceed immediately to one of the Flying Training Command's gunnery schools. Others are assigned at once to a tactical organization for combat duty, or to an advanced technical school for special training.

The top men from every graduating class are eligible for advanced technical training as aviation cadets, and after the successful completion of the advanced courses they are commissioned second lieutenants and sent to the Training Command's Officers' Training School for non-flying officers. From there they go to a tactical organization.

Some graduates become enlisted instructors. A few men get administrative or non-technical jobs. Others receive appointments to the AAF Officers' Candidate School and become commissioned officers scheduled for administrative duties.

Selective Service has poured recruits into Technical Training Command at the rate of 75,000 per month. Classification and basic training have required the facilities and manpower of 10 basic training centers at one time.

Whenever possible recruits are given their preference of AAF specialties. But war's quotas must be filled. A man who chose weather forecasting as his No. 1 preference may be assigned to study instrument maintenance, his No. 3 choice.

Morning after the last "processing," the men begin their training program. Their days are devoted at first to drill, and tough physical exercises. Extended order drill, the manual of arms, bayonet practice, sighting and aiming exercises, and firing of rifle, carbine, submachine gun, and pistol become habits that may save lives.

The technical school network is formed by the schools which give basic and advanced instruction to enlisted men. This training includes basic instruction for aircraft mechanics, armorers, machinists, metal workers, welders, clerks, Link Trainer instructors, parachute riggers, photographers, radio operators and mechanics, control tower operators, celestial navigation trainer instructors, teletype operators and weather observers. Advanced instruction is given in bombsight maintenance, power plants, electricity, instruments, propellers, weather forecasting, power turret and gunsight maintenance, radio and other fields. In the typical heavy bombardment squadron of today more than 300 of the 350 AAF troops are technicians—men who service and repair planes, operate communications systems, load bomb racks, rig parachutes, adjust bombsights, check weather and perform other necessary tasks.

The Technical Training Command was established around a nucleus of three Army fields, 14 civilian contract schools and the basic training center at Jefferson Barracks, Mo. Since then, dozens of new fields have been opened and some 452 hotels taken over to accommodate the enormously expanded program of instruction. Officer candidate schools, the officers training school at Miami Beach, and an aviation cadet school at Yale University are also operated by the command.

Biggest branch of the technical training division is that of airplane mechanics. Starting from scratch, men learn AAF service and maintenance, how to use tools and feel at home in repair shops. Propellers, instruments, engines, and the hydraulic, electrical and fuel systems are the textbooks—and major repairs are the final exam.

Aircraft machinists compose the group trained for repair and maintenance work in portable machine shops and more permanent installations to the rear of combat zones. Combat organizations and aircraft mechanics cannot expect a constant and adequate supply of parts to be available under all conditions and for that reason must be able to have parts fabricated on the spot at the front lines. An extensive array of machinist equipment is provided for this purpose, not only in the established repair depot, but also in the mobile service center. The same holds true of sheet metal workers and welders.

(Continued on page 248)

"Sampling" the breeze

AVIATION "experts" once opposed enclosing the pilot in a cockpit, claiming he needed to feel the rush of air upon face and body in order to tell what his plane was doing. Today the pitot-static tube protruding from wing or fuselage does this job with a lot more accuracy and dependability, transmitting dynamic and static air pressures to the instrument panel for the operation of the air speed indicator, the rate-of-climb indicator and the altimeter. Its rain- and-ice-proof construction assure accurate and continuous functioning under all weather conditions. The design and construction of Kollsman pitot-static tubes are representative of the skill that goes into all Kollsman precision aircraft instruments, long supplied for military and civil aviation.

THE CARGO PLANES OF TOMORROW *will differ in many respects, depending upon the service they are to perform. But there is one thing they will all have in common: instruments will play a tremendous part in their scope and usefulness. Kollsman engineers are constantly developing new and better aircraft instruments which will help widen and extend tomorrow's skyways for a new era in aviation.*

KOLLSMAN ELECTRICALLY HEATED PITOT-STATIC TUBES *are specially designed so that they are aerodynamically, mechanically, and thermally correct. Their construction ensures the faithful transmission of pitot and static pressures at all speeds and through all angles of pitch and yaw up to 16 degrees.*

KOLLSMAN AIRCRAFT INSTRUMENTS

PRODUCT OF

SQUARE D COMPANY

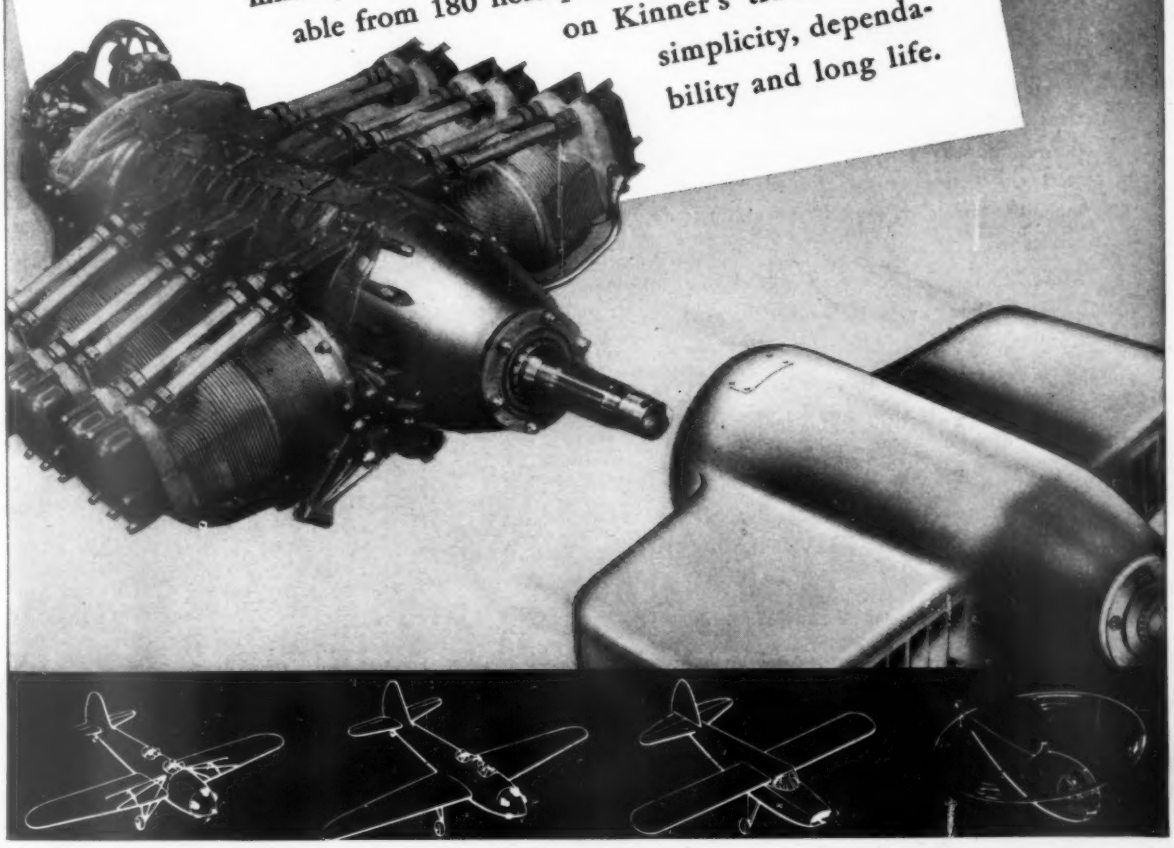
ELMHURST, NEW YORK • GLENDALE, CALIFORNIA

KIN
today
BUY WAR BONDS
KINNER MOTORS, INC. GLENDALE, CALIFORNIA

NER

. . . Tomorrow

Kinner radial engines, famous around the world for military, commercial and private use, soon will be complemented by another outstanding line—the new series of Kinner engines. Two years in development and earmarked for specialized military applications, these engines will be available from 180 horsepower up . . . and will carry on Kinner's tradition for simplicity, dependability and long life.



. . . professional mechanics choose Plomb hand tools

Throughout war industries today, Plomb tools of all kinds and sizes are helping build weapons to defeat the enemy. From the familiar screwdriver to intricate socket and attachment sets, outstanding performance and dependability have made them the choice of experts for better, safer, longer-lasting service.

These famous tools are available through the Plomb dealer in your community. Call him for the tools you need on your war job.

Remember Plomb performs a double service—consult Plomb Tools Contracting Company for special tools; call your Plomb dealer for regular ones.

PLOMB

PLOMB TOOL COMPANY
LOS ANGELES ▽ CALIFORNIA

(*Continued from page 244*)

Sheet metal workers and welders learn to recondition planes that come limping home from raids, punctured and pierced by enemy bullets. Their specialties include sheet metal work, aircraft metals and solders, radiators, metal tubing, Plexiglas.

Armorers learn about electricity—what a solenoid assembly is, how to service relay switches and magnetic controls. They fire and maintain small arms and machine guns; wreck and rebuild gun sights and bomb racks, and study power turrets.

Parachute riggers are trained to pack and care for the parachutes and flotation equipment on which the lives of aircrews depend. To qualify as specialists, riggers must "drop test" their chutes to open in 3½ seconds from airplanes at 250 feet elevation with 150-pound dummies attached.

Radiomen learn how to send and receive, repair, maintain and install aircraft radio, must master operational net and airdrome tower procedure.

Glider mechanics know gliders from nose to rudder, are taught to build new ones, if necessary, from the wrecks of a half dozen old ones.

Aerial photographers study photography by taking the picture, developing the negative, printing the result. For war's eyes they learn about mosaics, aerial cameras, projection and enlargement.

Weather observers learn to use and repair the instruments that measure barometric pressure, rainfall, wind-speed and direction, temperature, amount of moisture in the air.

Weather forecasters are a specially-selected group of observers trained in algebra, physics and trigonometry, who attend major colleges for advanced meteorology.

Teletype maintenance men are taught battery and generator characteristics, basic magnetic phenomena and circuit wiring, teletype circuits, repair of teletype machines.

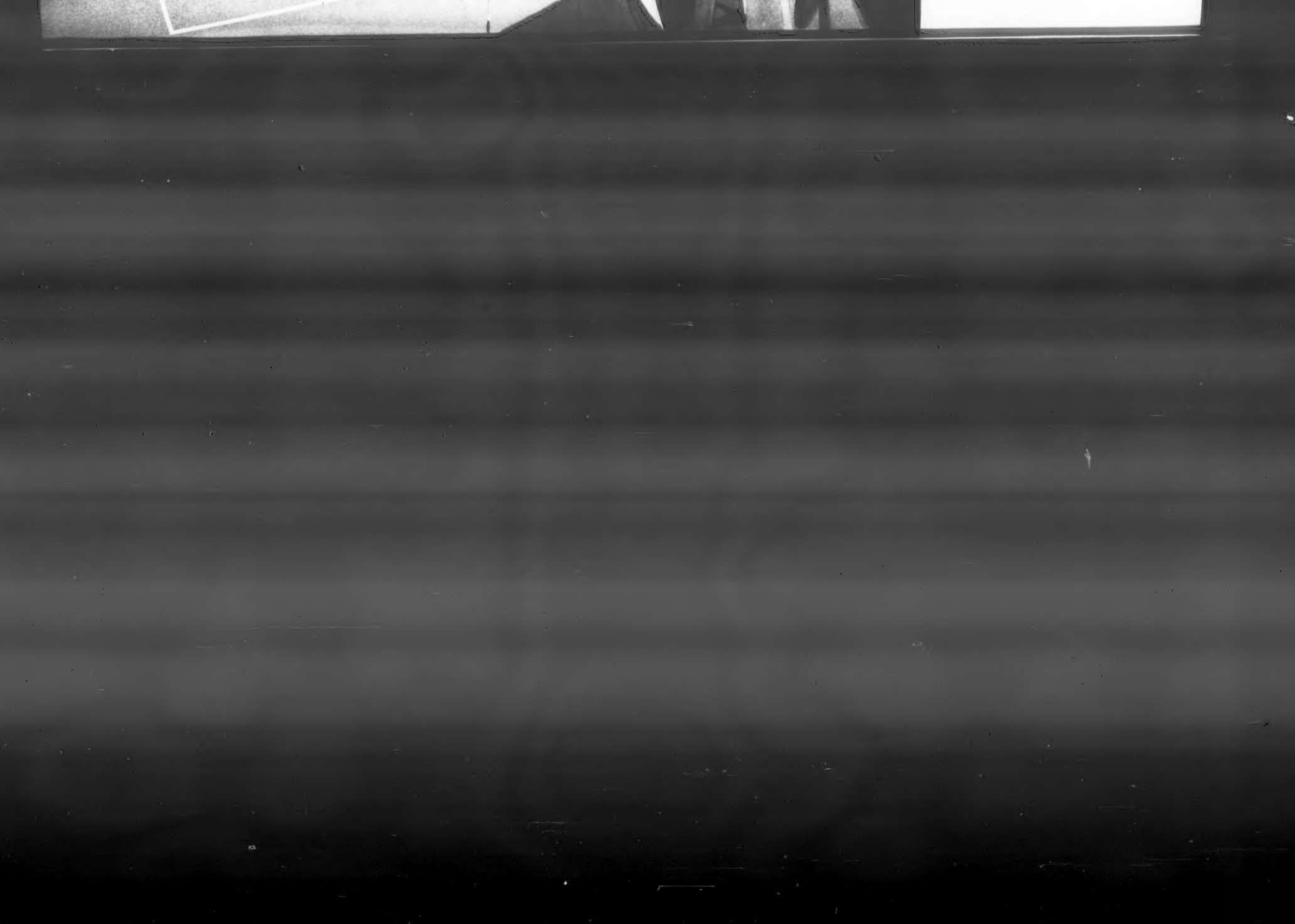
Aviation cadets in training detachments are schooled for the duties and responsibilities of technical officers.

The Officers' Training School at Miami Beach is both an orientation school for men commissioned directly from civilian life and a "refresher" school for administrative officers.

Specialized schools have included these: Air Forces Intelligence School at Harrisburg, Pa.; Administrative Inspectors' School at Fort Logan, Colo.; the Photographic Officer Pilot School at Lowry Field, Colo.; the Statistical Officers' School at Cambridge, Mass.; and administrative officers' training at Miami Beach, Fla. END

Combat Lunches

THE Quartermaster Corps of the Army has developed a special combat lunch for Army Air Forces bomber crews on flight missions of eight to 12 hours duration. Packed in units sufficient for three men, the combat lunch consists of food either requiring no further preparation or readily converted into hot dishes in planes equipped with electric hot plates or other cooking facilities.



Whether it's a spot landing on a flat-top's pitching platform—or a spot-shot at a warship of the Slinking Sun, American skills combine to complete the mission. And Johnnie hits the spot with nice precision. Success becomes almost commonplace when repetition dulls the edge of novelty. But the wonder of it grows when one considers what American aviation has accomplished in the brief period since Pearl Harbor. Johnnie Tojo also hit a spot that December day—a tender spot that annoyed America into building the greatest Air Force in the World.

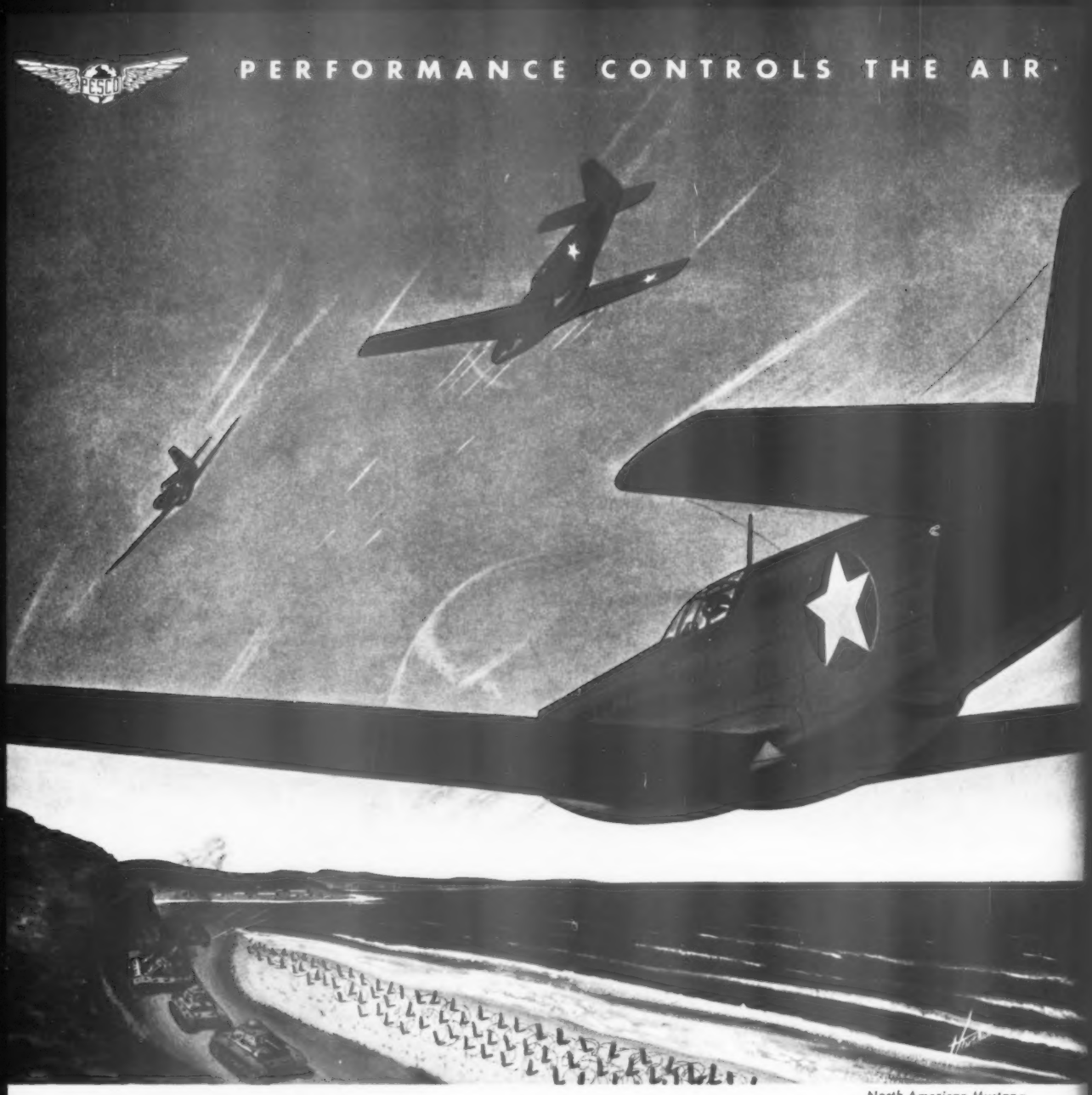
AIRCHOX COMPANY, Division of

JOYCE AVIATION, INC.

General Offices, 8S. Michigan Ave., Chicago

WORLD'S LEADING MANUFACTURERS OF AERONAUTICAL SAFETY EQUIPMENT

PERFORMANCE CONTROLS THE AIR



North American Mustang

Hydraulic Pump featuring exclusive PESCO pressure-loaded principle.

ARMY E NAVY

There they go! Roaring cannons on wings! Swooping from the sky . . . strafing . . . spitting streams of savage steel. In their wake, the mark of America's might. Hats off to the performance of those daring Yankee raiders . . . and to millions here at home from whose skill stems plane performance that rules the sky.

In Aircraft Hydraulics, Fuel Pumps, Air Pumps, Related Accessories . . .

PERFORMANCE POINTS TO *Pesco* FIRST

DIVISION BORG-WARNER, CLEVELAND, OHIO

Peacetime Pilots pointed the way

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Serving America's military aviation today—adding to your flying pleasure tomorrow.

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Since many years before the war, Heath components and assemblies have been in evidence on every airport in America. With this proof of product acceptance by experienced pilots and instructors, more and more aircraft manufacturers have turned to Heath for quality parts and assemblies—for solutions to plastics and plywood problems. We invite your inquiries.

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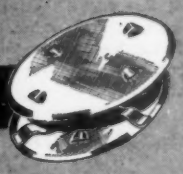
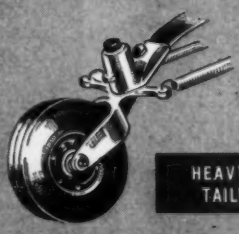
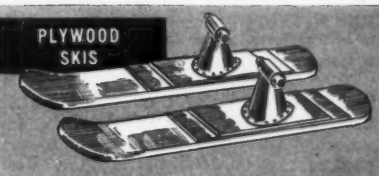
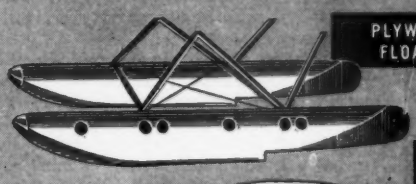



HEAVY-DUTY TAILWHEEL

PLYWOOD SKIS



PLYWOOD FLOATS



SKINNER AIR SCOOP & FILTER

MANUFACTURERS OF AIRCRAFT COMPONENTS

HEATH

BENTON HARBOR Company MICHIGAN, U. S. A.

NAMES the U. S. must never forget

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BEECH
BELL
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CONSOLIDATED VULTEE
CULVER
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FAIRCHILD
FLEETWINGS
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GRUMMAN
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NORTH AMERICAN
NORTHROP
PIPER
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STEARMAN
TAYLORCRAFT
TIMM
VEGA
VOUGHT SIKORSKY
WACO

LONG BEFORE the empty wastes of the oceans and the remote forests had awakened to the throbbing of motors of airlines or the Air Transport Command, air trails were blazed by pioneers. Clarence Chamberlin, Clyde Pangborn, Captain Mollison, *Newfoundland to Ireland! Japan to Washington State!* Many another.

If you remember when those names made headlines, you'll probably remember, too, the phrase, "in a Bellanca". Time after time, these rugged ships were chosen by air pioneers who were gambling with their lives against the unknown.

This aerial trail blazing put Bellanca planes on many a tough back-country cargo or mail line where they're still doing a vital job today, while Bellanca builds twin-engined Advanced Trainers for the Air Force.

SEEMS NO TIME at all since Roebling was turning out the control cord for the first "non-stop Atlantic flight" planes. As we look back, we realize that ever since we equipped the early "crates" with Aircraft Wires, we've been learning—toward the big job we're doing today. *Aircord Division,* John A. Roebling's Sons Company, Trenton 2, New Jersey. Branches and warehouses in principal cities.

*In these frequent messages, Roebling salutes each member of the aircraft industry in turn.

ROEBLING
means Control in the air

The Bomber Is Born

(Continued from page 110)

In December, 1936, a worried airman at Seattle penned a letter to his boss.

"Dear General," wrote Maj. John D. Corkille, Air Forces representative at Boeing. "One of the eastern papers this morning stated that the B-17 was too large for Army pilots to handle. Any pilot who has flown heavy planes can fly it. This plane will take off short, land short, will carry heavy loads and is very fast. It is the last word in airplanes."

From "the general," Henry H. Arnold, at that time assistant chief of the Air Corps, came reassurance:

"I agree with you about the B-17 and things are not as bad as they seem, so cheer up and don't worry too much about what you read in the papers."

In the next few months, *Fortresses* flew higher, faster and farther, with heavier loads than any other military plane. Langley Field pilots took them to Buenos Aires, to Rio, Bermuda, and Bogota, Colombia.

Wright Field had ordered a 14th B-17 for "static testing." In 1938, however, a heavily-loaded *Fortress* stalled without warning, spun through overcast, landed safely on bent wings. The B-17 had withstood more strain than its designers claimed. No laboratory could have proven more.

The Materiel Division rushed the test model to flying status and installed turbo-superchargers. The YB-17A, rescued from a dull life on the ground, became the first stratosphere bomber.

Meanwhile the Air Forces, which never has put all its eggs in one basket, sought another four-engined bomber as teammate to the B-17. Consolidated Aircraft got the nod with a land-based cousin of its giant flying boats.

Within nine months, the Consolidated B-24 grew like a well-designed house whose builder watches the trails and errors of other men. From early Martin to late Boeing, Consolidated profited from aviation's past.

All through the summer of 1939, while the B-24 was building, the B-17 celebrated the Air Forces' 30th anniversary by smashing the big-bomber records of the world for speed, load and altitude. The first B-17B set a non-stop, transcontinental record.

Then war made record-breaking the business of victory. And war forced the world's airplanes, ready or not, into the air.

General Arnold recognized this. He knew that minor design changes must not freeze production. His motto: Get 'em built.

He also watched the future that must safeguard the present. "No foreign country," he said, just before Poland fell, "should ever have an experimental airplane with greater range than an experimental bomber of our own."

The *Fortresses'* record-breaking flights had given the Air Forces a whopping birthday present. On December 29, 1939, Consolidated had its Christmas present ready and test-flew the new big bomber successfully for 20 minutes over San Diego. Its official flight came two months later. The B-24 had slimmer and higher wings, a fatter fuselage than the B-17, twin tails instead of the Fortress' single "dorsal fin."

In remarkably brief time, the B-24 had emerged from the drafting board to a perfect take-off—but in that time war blew the lid off plane production and the sky was the limit.

The Air Forces, airplane companies and the nation's auto-makers went into a huddle to reduce man-hours per plane and adapt assembly-line methods to bombers. The runways came to Detroit. The Wright Brothers' bicycle shop had been swallowed in Willow Run.

Well before Pearl Harbor *Fortresses* and B-24's were battling for Britain. *Fortresses* struck the Brest docks, bombed Hamburg, attacked Nazi convoys in the Mediterranean. Equally valuable were the new B-24's, which the British named the *Liberator*—a fighting word at a time when German power had swept Europe.

Two formations of B-17's sped to the Philippines just before Pearl Harbor. By no means the 1943 super-bomber, they battled Japs from the Indies to Australia. Combat missions tested guns and armor. Power gunnery was improved. More gunners were trained. Within weeks, the deadly "stinger" in the *Fortress'* tail was killing every Jap in range.

A *Fortress* brought Colin Kelly a hero's fame. Another evacuated General MacArthur from the Philippines. A third, flown by Capt. Hewitt Wheless, fought off 18 Jap Zeros, bombed its target 500 miles from base, limped home the last 400 miles on two engines.

For the Wheless exploit, airmen could thank Wright Field's Materiel Division which condemned the *Fortress'* original fuel system as "a pile of junk." Air engineers knew nothing could save a bomber with fuel lines aflame.

Today's *Flying Fortress*—the B-17F—is bigger, faster, tougher. Yet its design was born in Model 299 that crashed with Pete Hill in 1935.

Fortresses and *Liberators* are our preview of tomorrow. They're the most efficient, most versatile stop-gaps in history, the "last of the small bombers," as General Arnold called the *Fortress* not long ago.

Seeking bombing skill to match their planes, airmen checked practice bombing scores and found some eye-openers. They proved, for instance, that if bombing mirrors are cut in half, efficiency is raised *four times.* A bombing force that became twice as good at hitting one target could hit *three more targets.*

America's pioneer airmen have taught fledglings one basic law: *Every bomb must pay its way.* Students hit the target or they don't win wings and commissions. Hits on *one* ship, *one* drydock, *one* power plant can hurt the enemy. Why waste time and bombs on bad guesses? EN

Lewis— MEETING AVIATION'S NEEDS FOR TODAY and *Preparing for Tomorrow*

LEADING Aviation to ever new horizons—whether in war or in peace—is the challenge and vision of the Lewis School of Aeronautics . . . America's Aeronautical College of the Future.

TODAY Lewis has the important job of training AVT Flight officers for the Navy. *TOMORROW*—when Victory is won—Lewis will again be training the youth of the nation in peacetime aviation.

Lewis is a fully accredited Aeronautical College. The courses have full recognition by both Federal and State Aeronautical authorities as well as the United States Office of Education. Lewis instruction in Flight, Master Mechanics and Aeronautical Engineering is the finest offered anywhere.

Applications for registration in post-war courses are now being accepted as far as possible in order of their receipt.

FREE CATALOG – 42 pages of interesting, detailed information on the Lewis School, its facilities, accommodations, faculty, courses and subjects. Designed to help you select the courses best suited to your abilities. Write for your copy today!

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CONTRACTORS TO THE UNITED STATES GOVERNMENT

Working for DEAR LIFE

Rrrr-up . . . Rrr-up . . . Rrrr-up . . rup . . rup . . up . . Minute after minute . . . hour after hour . . . day after day . . . this staccato machine-chatter goes on, down the long lines of intense operators in the Switlik parachute factories. ☆ ☆ ☆ Sewing for dear life, indeed, that the precious lives of those few, to whom so many owe so much, shall have that vital protection against the hazards of combat flying. ☆ ☆ ☆ Thru the genius of Switlik engineers, Switlik methods of production have been developed that are daily establishing records in making more chutes and faster deliveries for protecting those lives which are speeding up our march to Victory.*

SWITLIK
SAFE-T-CHUTES

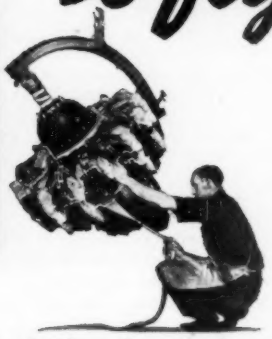
*Two one-hundred-dollar bonds put a paratrooper back of the Axis!

Do your best for the 3rd War Loan drive.

SWITLIK PARACHUTE COMPANY
Trenton, New Jersey

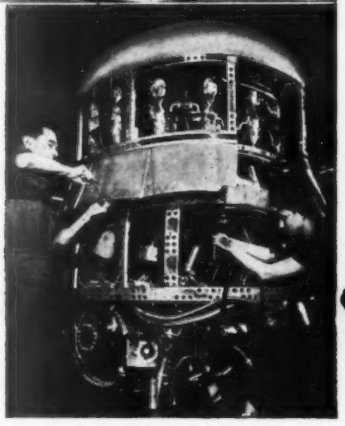
Copr. 1943 Switlik Parachute Co.

1200 horses get ready to fly!



ROHR

PARTS ☆ ASSEMBLIES



ROHR craftsmen bridge the gap between power plant and airplane with thousands of intricate operations which include both manufacture and assembly.

The painstaking precision of their work contributes to the stamina and reliability of many of America's famous bombers, cargo carriers and giant patrol planes.

Day and night on Rohr's production lines, huge motors move forward to meet the ever increasing tempo of the war's demands . . . a tempo matched by the high spirit of Rohr Production Fighters who know that speed in the factories saves lives at the front!

HELPING TO WRITE
THE STORY OF TOMORROW

ROHR AIRCRAFT CORPORATION • CHULA VISTA, CALIFORNIA

"AAFSAT"

(*Continued from page 82*)

large percentage of the lectures received by officers in a bomb group cadre.

Everyone is brought up to date on the latest tactics used by the enemy in various theaters. For instance, with a clock diagram superimposed on a bomber, current classes are being shown how Nazi fighters have in the past year shifted the larger percentage of their attacks on Allied bombers from five to seven o'clock position to the 11 to 2 o'clock sector in the nose area. Subsequent intelligence will show how a now-secret flight formation proved to be the antidote for assaults from that quarter.

Heavily stressed is the brainwork that must go on hours and days before a bomb is trundled out to the planes. Operational Intelligence, Armament, Communications, Navigation, Flying Control, Weather—all these come in for a big share of the classroom instruction for bomber cadres.

For instance, it is sharply pointed out to the AAFSAT bomber student exactly what he can expect with certain type bombs, why, for instance, a bomb that detonates from mechanism in the tail is better against armor plate than a nose detonation. In bomb selection there is a huge morale factor to be considered, both from the crew's standpoint and that of the enemy target. A survivor of the original poorly-equipped, poorly-armed missions in the Southwest Pacific area, for instance, knows the morale slump that hits a crew when the racks carry only 100-pounders. It is vital to know which type bomb is best for a train or a water supply system. It is even pointed out how morale-shattering the 4,000-pounder is to a civilian population in winter—not so much for the total destruction as for the window-shattering qualities.

In addition to teaching the doctrine and technique for precision bombing, AAFSAT impresses on its students the importance of bringing home those quarter-million dollar bombers and their valuable crews. For this, the new science of flying control is being improved and taught at AAFSAT. New tactics which enable a crippled bomber to get away from short-ranged enemy fighters is a basic course at AAFSAT.

In its academic area, AAFSAT has literally "moved heaven and earth" to bring to its bombardment students the latest in synthetic training devices.

For navigators there is a custom-built heaven with a full stock of stars that can be set exactly as the constellations will be the night the student makes his first run over an AAFSAT theater target—or Berlin, or Yokohama. Bombardiers watch screens displaying the terrain of the very target area they'll be plastering several days or months hence. They'll bomb these targets, registering synthetic hits and misses.

Amazing as is the wonderland of synthetic material, a majority of the students will spend the greater part of their AAFSAT time in tents and planes out at one of the bombardment airdromes. They'll be working 12 and 18 hours daily running missions far out into the Gulf of Mexico or across the AAFSAT area. These missions, from briefing room to target and back to intelligence interviews, will be duplicates of raids already made in this war. These raids are superimposed over Florida and re-run for the lessons in both offensive and defensive tactics. Leaders in these missions are officers who actually participated in the flight when they were "playing for keeps" in the Southwest Pacific, in Africa or over Germany.

A ground force commander prays, via radio or field telephone, for a long arm to quiet Axis batteries just outside the accurate range of his artillery; or an enemy truck column moving up supplies to a force threatening his flank; or his intelligence reports that sufficient paratroopers could take and hold that next bridge, until his tanks arrive. His answer comes from the Air Support Command.

The jack-of-all trades assignment of an Air Support Command calls for the utmost in versatility, flexibility, ingenuity and daring. Therefore, in the Air Support Department at AAFSAT, cadres destined for work with the nation's infantry, artillery and tanks find a many-sided, fast-changing training program.

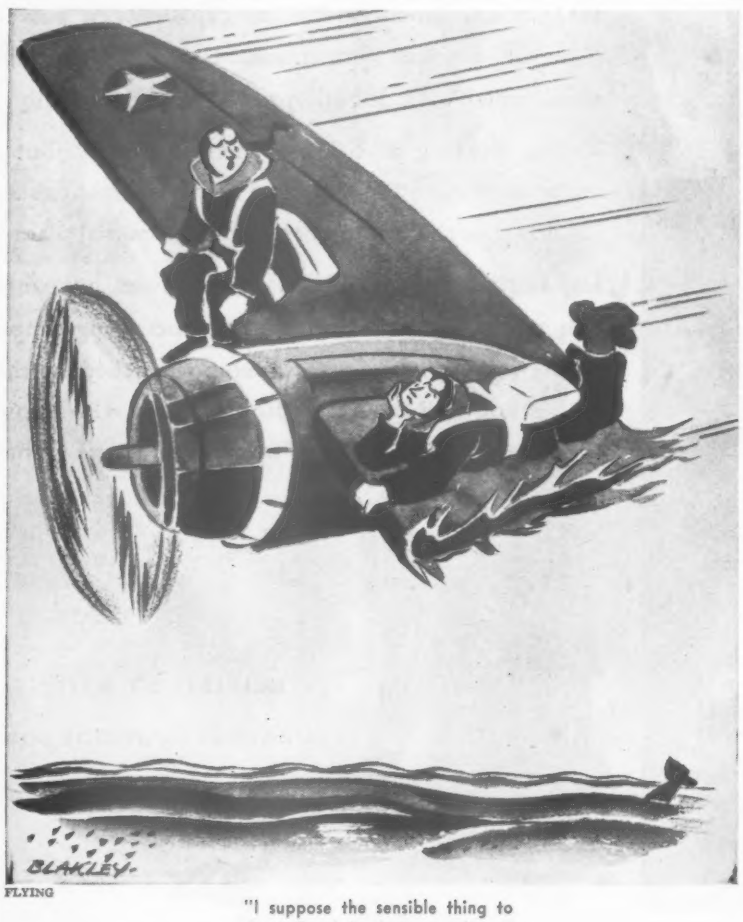
The AAFSAT Air Support Command has three bases in Florida. Nearby are large infantry camps, amphibious troop training centers and paratroop schools. Thus, both ground and air fighters are afforded an opportunity to work and maneuver with each other.

At AAFSAT student commanders and operations personnel learn the almost split-second co-ordination that must exist between the commander of the ground forces and his air support squadrons to soften up enemy resistance at the front and on the flanks. They see the tremendous importance of a highly-developed communications network between air support bases and ground force headquarters.

Air Support cadre personnel, many of whom have had no dealing with ground forces in their Army life, get instruction in the tactics of the ground elements they are to assist.

At AAFSAT an almost rifle-accuracy in low-altitude bombing is taught the pilots of light bombardment planes which maneuver so swiftly and so low that the scrawny Florida pines tickle their bomb-laden bellies. Dive bombardment also comes in for its share of demonstration.

(*Continued on page 260*)



"I suppose the sensible thing to do is head back to our base."

Thanks to "HEARTS—EYES—BRAINS" by

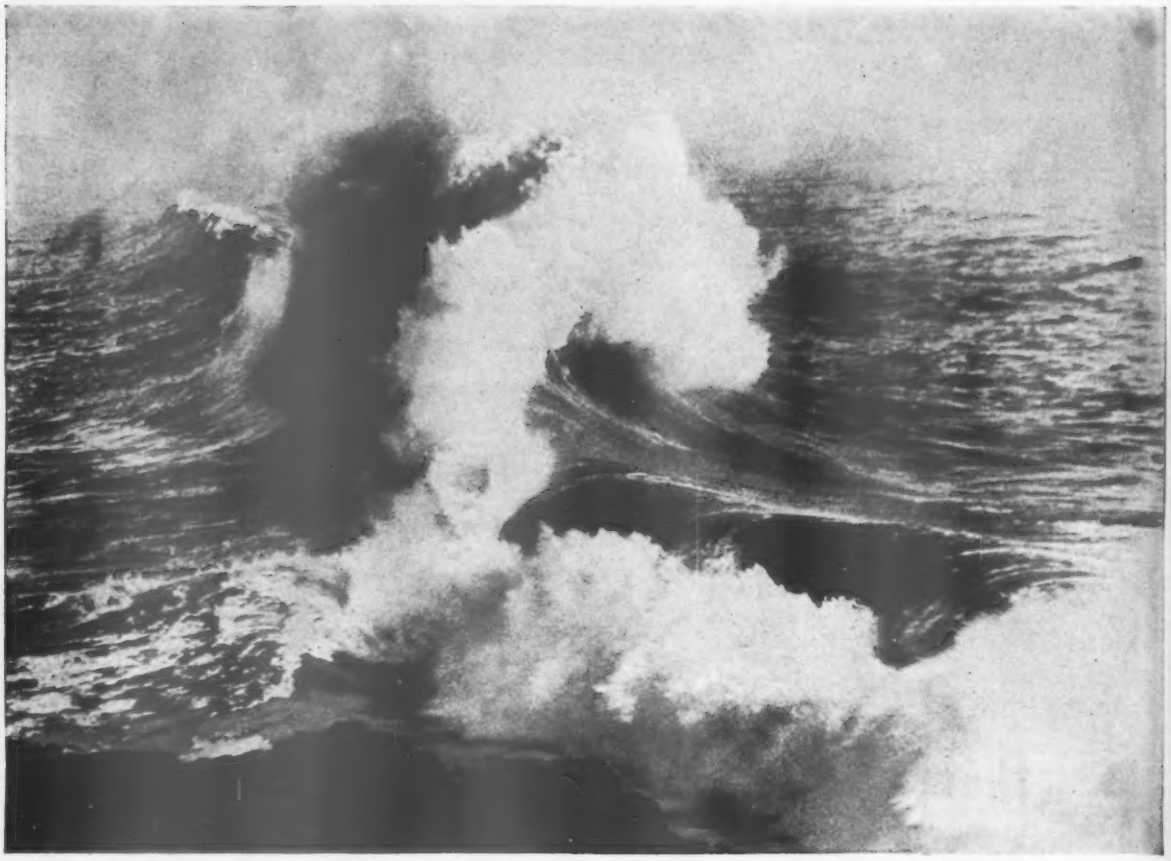
B·U·L·O·V·A

These "hearts — eyes — brains" are high precision war instruments vitally needed by every branch of our armed forces.

Deadly effective as they are, such devices do not, and cannot, compare with the indomitable courage of our fighting men. But their unbelievable accuracy does prevent human error... does provide the devastating precision that's blasting the enemy out of the skies, out of the seas and off the ground!

Bulova is proud that the "know-how" of our craftsmen is so well adapted to this vital work. From their skilled hands flow an ever-increasing quantity of fine Jewel Bearings, pioneered by Bulova, for precision instruments that enable ships to navigate and planes to fly . . . Also . . . Altimeters, Rate-of-Climb Indicators, Navigation Watches and Clocks, Telescopes, Time Fuzes and other war instruments.

Naturally, your jeweler's supply of Bulova Watches is limited. So, if you have to wait for your Bulova Watch, please be patient.



This is the reason they called the tube KLYSTRON*

Does it seem far-fetched to you?

Can there be any possible similarity between an ocean wave and an ultra-high frequency tube?

As a matter of fact, there's a very definite similarity.

A breaking wave is the best way we know to picture what happens to electrons in the KLYSTRON tube invented by the Varian brothers—Russell and Sigurd—and Dr. William W. Hansen.

Inside this tube, the inventors were able to direct a stream of electrons which concentrated their power and released it much as waves do when they mount into crests and crash on the shore.

That's why the tube is called KLYSTRON. The name comes from a Greek word that denotes the breaking of waves on a beach.

Initial research on the KLYSTRON was done in California at Stanford University. The Sperry Gyroscope Company was quick to see the tube's possibilities. So they helped the inventors carry on further development of the KLYSTRON as a valuable tool of war and aeronautics.

When the tube got beyond the early experimental stages, the Varian brothers and Dr. Hansen joined Sperry's staff of inventors, engineers, and research men.

With the close co-operation of the Army and Navy, the development and perfection of the KLYSTRON continued, and is still continuing.

Applications of the KLYSTRON include the generation, amplification, and reception of ultra-high frequency waves. Naturally, they are being devoted exclusively to war uses at present.

When the war is won, Sperry research will explore the fascinating field of KLYSTRONICS** in relation to the comfort and security of a world at peace.

SPERRY

GYROSCOPE COMPANY, INC.

BROOKLYN, N. Y.

Division of the Sperry Corporation

*KLYSTRON is a registered trademark of the Sperry Gyroscope Company—Registration No. 371650.

**Trademark

BORN: FEBRUARY 8, 1941 WEIGHT: 1926 LBS. 8 OZ.

I'm the Primary Trainer the Army Air Forces Spent Years to Develop. I'm Safe as a Cradle.

Officially, I'm a Boeing PT-17 Kaydet... now one of thousands. 27 months ago I was first on the flight line at THUNDERBIRD FIELD. Hundreds of cadets have nestled in my cockpit for their solo flights. 225,540 miles are behind me... 8½ times around the world... and I'm still going strong. I'm helping... right here in Arizona... to make the air safe for all the world.

Behind the Scenes is that unsung crew of mechanics that keep me ticking... keep all of us PTs ticking for thousands of hours. Every morning they check me over... check me in detail three times a month. Only once have I been off the flight line for more than a day.

I remember my first trip to "Overhaul." 1512 hours, I'd had, in the air. There, expert hands found and fixed my bumps and scratches... again replaced my motor. This is my third, freshly overhauled... sweet-running.

No wonder I've brought cadets in safely 7,267 times... and I'm still as good as new.

Here's Why I Tell You All This. When war made expansion necessary, the Army Air Forces turned to selected civilian schools like "SOUTHWEST" for assistance. In me the flier is born. Later the fighter is made. Primary training is the foundation of it all.

Bet your bottom dollar we PTs are made and *kept* in perfect condition as part of Army's program to quickly, yet safely develop the most competent fliers in the world.

SOUTHWEST AIRWAYS

Phoenix, Arizona

THUNDERBIRD FIELD • FALCON FIELD • SKY HARBOR • THUNDERBIRD II
TRAINING THE FINEST FIGHTERS TODAY, THE FINEST FLYERS TOMORROW
CONTRACTORS TO THE UNITED STATES GOVERNMENT • UNITED STATES ARMY • UNITED KINGDOM GOVERNMENT

. . . and Republic stands for Speed!

"THUNDERBOLT WORLD" Is only 7 miles from where you sit as you read this. But, chances are, you've never been there, for it's 7 miles *straight up.*

It takes *punch* to get a Yankee fighter pilot up . . . up . . . up . . . into the midnight blue sky of "Thunderbolt World"—and keep him there, better than the best the Jerries and Nips can send. Punch of a singing 2000 horsepower, turbosupercharged. Punch of 8 guns, caliber 50 ** 6½ tons of punch, moving at over 400 m.p.h., with every inch of its length and span packed with flying and fighting equipment.

Mark Thunderbolt — another leader in America's long list of specialized aircraft built for specialized jobs. And mark Thunderbolt World as a region where 400 mile-an-hour mail, and cargo—and even *you* may travel, come Victory!

PACKING flying and fighting power into American aircraft is the maker's job. Keeping that power on leash is Roebling's job. Next time you see a fighter bore into the blue, give a thought to the quality of the slender steel cords that swing its controls at the pilot's touch. *We're thinking of it 24 hours a day. Aircord Division,* John A. Roebling's Sons Company, Trenton 2, New Jersey. Branches and Warehouses in Principal Cities.

NAMES the U.S. must never forget

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BREWSTER
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COMMONWEALTH
CONSOLIDATED VULTEE
CULVER
CURTISS-WRIGHT
DOUGLAS
FAIRCHILD
FLEETWINGS
FLETCHER
FORD
G & A AIRCRAFT
GENERAL MOTORS
GOODYEAR
GRUMMAN
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*In these frequent messages, Roebling salutes each member of the aircraft industry in turn.

ROEBLING
means Control in the air

(*Continued from page* 256)

Another important mission of Air Support—observation and photography — is being developed at AAFSAT, where pilots of fighter-type aircraft learn to streak into an enemy area, photograph it with the fastest cameras in the world and be gone before ack-ack-guns or fighters can be alerted.

At one of the AAFSAT Air Support Command bases, procedures and tactics for evacuating the sick and wounded by air are being worked out. At the same base troop carrier squadrons, co-operating with airborne infantry outfits, develop the best tactics for landing troops by plane, glider and parachutes in enemy-held territory. In emergencies it is also an Air Support function to supply the troops landed in that manner.

To insure the best control possible for the ground force commander (who must use a bombardment squadron with as much accuracy and skill as he would use a limited amount of artillery when clearing a way for his troops) the communications section of the Air Support Command is one of the most vital in its many-sided functions.

Every plate of beans, every mechanic's toothache or laundry, every aircraft part from a pea-sized nut to a four-engined bomber, every drop of 100-octane gasoline or gram of explosive is a responsibility of the Air Service Command of an air force.

The situations that "snafu" an air force in its thrust at the enemy are met face-to-face under theater of operations conditions by students at AAFSAT.

With an Air Force commander's supply and service bible, AAF Regulations No. 65-1, the Air Service department of AAFSAT teaches all administrative supply and service personnel in fighter, bombardment and air support cadres as well as the key men in the various air depot groups, supply squadrons, service groups, quartermaster, ordnance, engineer, signal and airdrome outfits.

The AAFSAT air force has its own general depot and all the elaborate service and supply networks that an independent air force would have in a theater. Its large hospital layout serves as a general hospital.

Out front in the AAFSAT theater is the service center area, where a complete demonstration service group is so well camouflaged that one would never suspect that the third echelon maintenance for nine air fields is being handled by mechanics and mobile equipment hidden away there.

Quartermaster trucks from one depot supply nine AAFSAT installations with their daily food, giving 24-hour service. A bakery on wheels provides fresh bread daily for outlying installations. Trucks on their return trips bring in salvaged clothing and equipment. Mobile laundries provide clean clothes for troops in the field. Mobile shops handle shoe repairs.

Into this highly mobile and thriving service set-up are sent the AAFSAT students for training. They, too, are quartered in tents and temporary barracks, living on what is brought in daily by truck—and, in some test operations, flown in by air. An airplane mechanic who has spent most of his Army life working in well-stocked, elaborately-tooled hangars gets his final lesson in motor overhaul under the shade of a small oak tree, using parts checked out of a mobile supply truck and doing fine lathe work in machine shops on trailers.

To add realism to the operation, marches and truck convoy movements are made with air protection and simulated air attack. An aviation engineer outfit works at building a theater of operation airdrome. Around all tents and at strategic points for repelling an attack are slit trenches and cleverly hidden subterranean command posts. Such units are occasionally tested with a surprise visit by paratroops.

In this way, the adjutants, the supply and intelligence personnel, and all others holding what have been called "GI white-collar" jobs are taught to handle administrative jobs on one hand and be ready to trade a typewriter for a tommy gun on a moment's notice.

AAFSAT doesn't confine itself to teaching in its four departments—bombardment, air defense, air support and air service. Each department has its own test and development section where experts, scientists, pilots and tacticians do research and pioneering work in the tactical use of new equipment.

A new-type fighter, for instance, is hatched out of a factory. It was built under specifications of the Materiel Command, Wright Field. The AAF proving ground tested it for strength, endurance and fire power. But the test and development section of AAFSAT's Air Defense Department gives it the final working over and examination for use against known enemy capabilities.

The Army Air Forces Board (consisting of the assistant commandants of the four AAFSAT departments, the director of tactical development and other members named by the commanding general, Army Air Forces) then review the report and pass it on to the commanding general of the Army Air Forces with recommendations for improvements in the plane, or for its best use in combat.

Most of the new equipment and methods used in the Air Forces all over the world will be passed on by the AAF Board, whether it's goggles for night fighter pilots, radio equipment for locating lost pilots or a new field manual for a specialized type of aviation.

The co-ordinator of all this reseach is the AAFSAT director of tactical development. His is one of the most important tasks in the school. If intelligence reports that the Japs or the Germans have a new type weapon, it's his job to get something developed out of what we have, or can produce, which will counteract it.

AAFSAT is also an "intelligence bank" for the Army Air Forces. On hand are the newest tactics and techniques of our weapons and equipment, and information on what the enemy is up to in every theater.

The heavily-guarded Air Room at AAFSAT, with daily-posted situation maps and last-minute intelligence from all

(*Continued on page* 268)

FOR FIGHTING FLIGHTS TODAY—

As a seasoned builder of precision devices, AC Spark Plug Division of General Motors Corporation was selected,—in some instances before Pearl Harbor,—to make several products for the air war. Today, the United States Army Air Forces, the United States Navy, and the Royal Air Force are using these AC products. The list includes, in addition to Browning .50 calibre machine guns, a new ceramic type AC spark plug, the Sperry Automatic Pilot, special silver lined engine bearings, oxygen pressure gauges, torpedo directors, and bombsights.

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AC plants proudly display the Army-Navy "E" burgee, with white star, for outstanding production achievements; and also the "Minute Man" flag, which indicates that AC workers are investing 10% of their income in War Bonds and Stamps.

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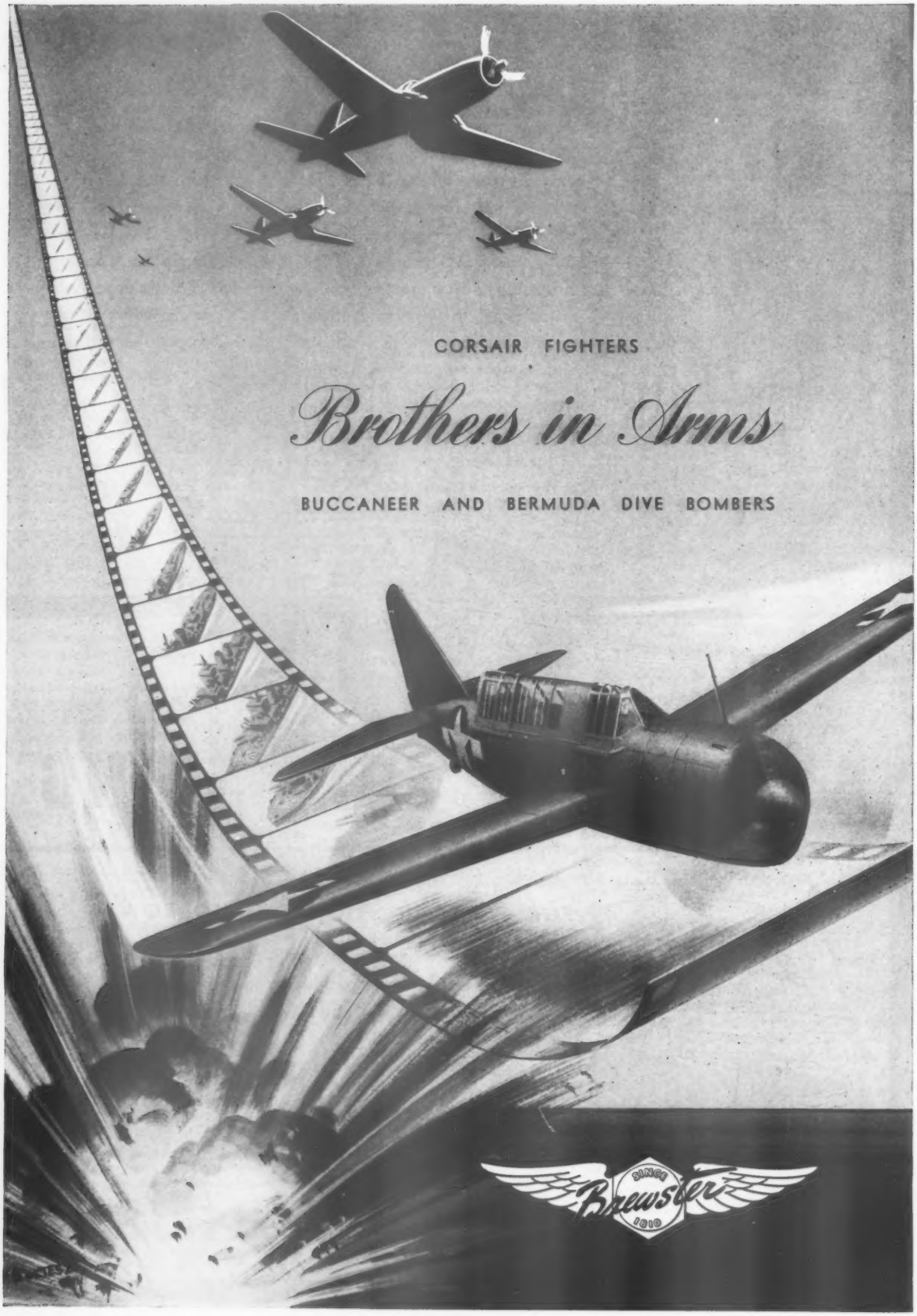
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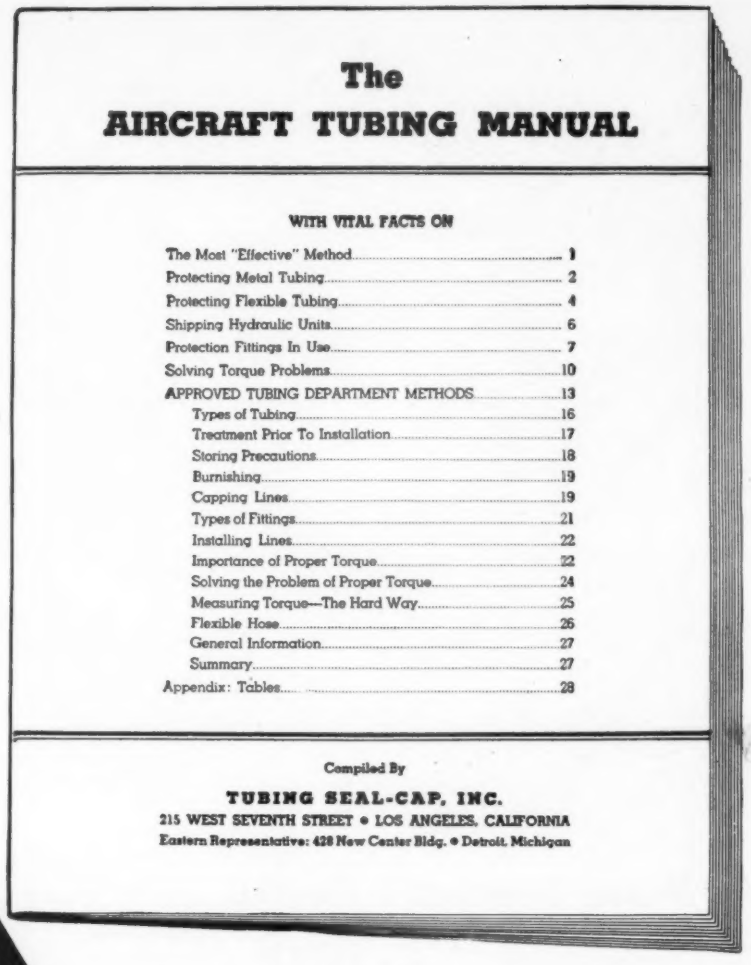
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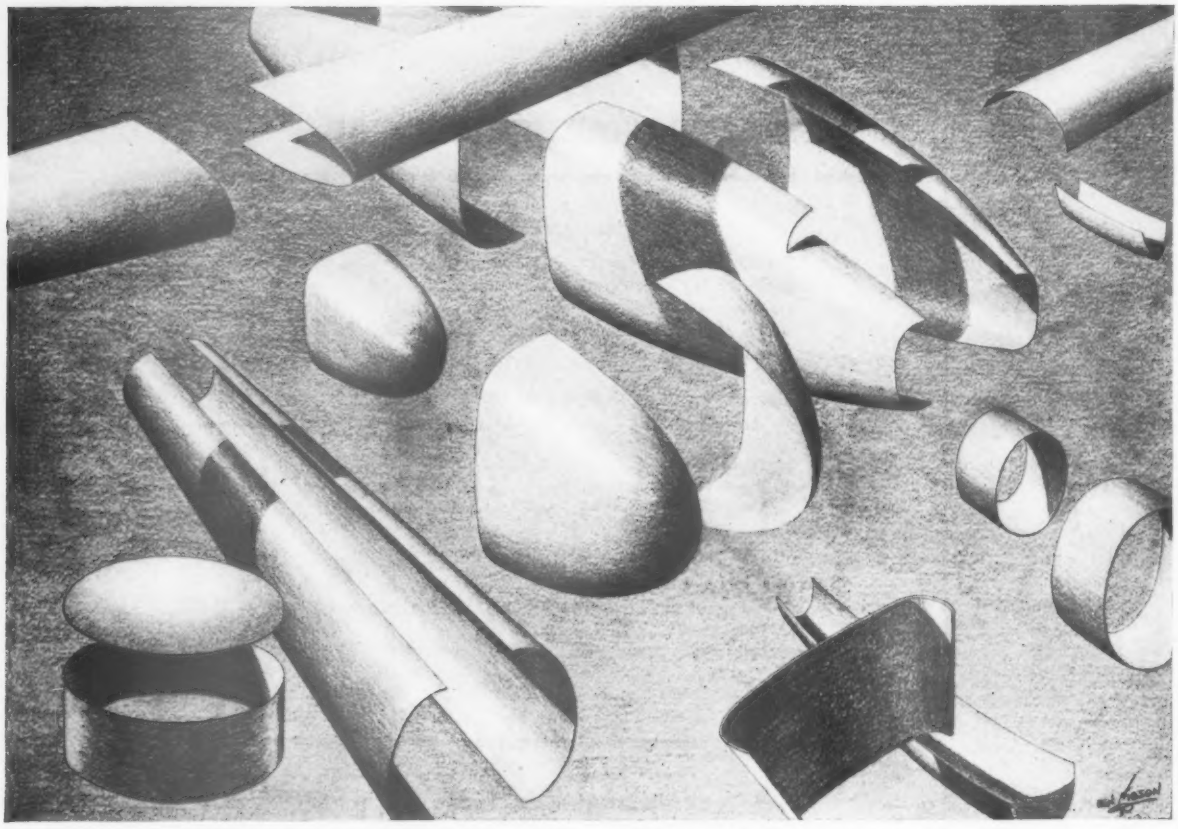

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Nor can America forget the Aeroncas—those that taught our boys to fly the day before yesterday as well as those that are spotting and bearing messages today! America is proud of Aeronca for a long job carried to a stirring conclusion—as they'll be proud tomorrow of the Aeroncas and other family planes they're going to be flying! For with the experience Aeronca has gained in adapting its production to turning out a plane like the Grasshopper *for a specific wartime job*, there can be no doubt that Aeroncas will continue to fill the bill—whoever writes it!

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*In these frequent messages, Roebling salutes each member of the aircraft industry in turn.

ROEBLING

means Control in the air

(*Continued from page* 260)

the theaters, is a front-row seat for the far-flung air and ground operations all over the world.

The cadres streaming through AAFSAT, in courses revised and brought up-to-date every two weeks, get transfusions of the latest information as it applies to their special jobs. That, together with the first-hand reports from instructors who only a few weeks previously were in actual air battles, give the cadres a briefing on what they are about to face such as no other Air Force personnel ever enjoyed. AAFSAT observers make round trips to the theaters to see how AAFSAT-trained airmen fare.

AAFSAT is also a crossroads of the air heroes of this war. In addition to the hundreds who go there soon after returning home, to be interviewed by intelligence officers for all they know, others come back as the heads of newly-activated cadres.

Students alone are not the sole missionaries for gospels of new techniques and tactics developed at AAFSAT. Special demonstration crews, virtual traveling salesmen, go direct from AAFSAT to air forces in the theaters, to demonstrate the use of a new bombsight, radio device or other "hot" improvement.

Yes, AAFSAT is a prodigious undertaking, a revolutionary sort of school. Progressive airmen several years ago envisioned the dire need for AAFSAT while they were students at the small Air Corps Tactical School at Maxwell Field. Most of them, now generals and colonels, will be interested to know that AAFSAT inherited the ACTS motto: "We progress unhindered by custom." END

Bombs

(*Continued from page* 113)

been so designed that they break into 1,000 to 1,500 pieces weighing about .3 ounce, with velocities up to 4,000 feet per second. At 200 feet, the fragments will go through a wing or gas tank, cut through tires and control wires, perforate radiators and intercoolers. Ground crews need 25 to 30 hours to repair planes damaged by fragments of bombs placed 90 feet or less from the plane.

There are two kinds of fragmentation bombs. One is anti-personnel, designed to burst on contact with the ground and spray missiles the size and speed of a .30 caliber rifle bullet. One design has fins for high-altitude release, either singly or in clusters.

By using a mechanical time fuse in a fragmentation bomb of the fin type, this bomb can be dropped on a lower flying formation of airplanes and made to explode in their midst. This is the anti-aircraft fragmentation bomb.

Realists always, air ordnance experts have not neglected chemical bombs and the enemy knows that they will be used, if necessary, in retaliation for gas attacks. Some samples:

1. Gases of the type called harassing agents hinder operations of troops by forcing them to wear gas masks or to remove them in order to sneeze or vomit, thus rendering them vulnerable to more potent gases.

2. Casualty agents, such as chlorine, mustard gas and phosgene, do bodily harm.

3. Screening smokes produce dense obscuring smoke in the air.

4. Incendiary agents produce a tremendous amount of heat, set fire to combustible material.

The chemical bomb case is light steel, may be filled with almost any chemical agent, weighs about 100 pounds.

Filled with mustard gas, it becomes a casualty bomb. A filling of white phosphorous makes it an incendiary or smoke bomb.

A plane may carry 1,500 to 2,000 small incendiary bombs. These weigh about four pounds, burn at temperatures of 3,300° to 4,500°, can start fires in cities, airdromes or encampments.

Hand in hand with combat operational bombs, the AAF at war uses vast quantities of practice bombs. These are the key to marksmanship. Training with the 100-pounders is only a step from laying the real "eggs." The AAF has not been content to develop bombs. Our airmen have learned to use them with devastating effect.

Latest technique is minimum altitude, or skip, bombing which proved so effective in the Battle of the Bismarck Sea. By this method the planes attack at maximum speed from an altitude just high enough to clear surface obstructions. The bombs are dropped with such extreme accuracy, even against moving targets, that no tank or armored vehicle is safe. New sights had to be developed, new fuses made. [An illustrated description of the Army's skip-bombing technique was published in the September issue of FLYING.—ED.]

Another special tactical method is high-altitude night bombing. Flares dropped to illuminate the target descend to a certain predetermined altitude. Here a special fuse causes a parachute to open, allowing slow descent of the flare. Then the fuse ignites the flare, which burns with a brilliancy of 800,000 or more candlepower.

Every mission requires its own bombs and fuses, its own tactics for a custom-built attack on the target. This is a game as grim as death and it has three fundamental rules:

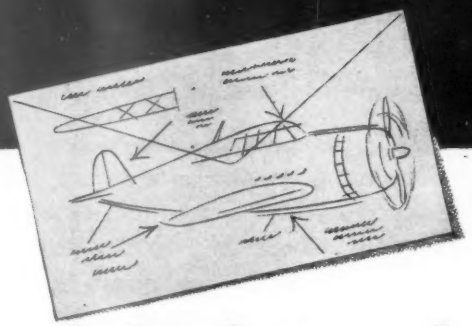
1. Always use a bomb of sufficient size to accomplish the destruction desired. If a 1,000-pound bomb is required, a 600-pound bomb will not suffice—and a two-ton monster is wasteful.

2. Having determined the proper size of bomb, never use a heavier bomb, but carry more of the right weight bombs and thus increase the probability of securing the necessary hits.

3. Select the fuse that will give the maximum effect against the given target.

These "tactics of realism" explain American bombing triumphs in every theater.

We have the world's best bombers, the best crews, the best bombs. In all of these—together and not singly—we have tools to win the war. END



The envelope that helped to seal the fate of the Axis

• It was late summer 1940; war clouds were growing darker.

High-ranking Army Air Force officers and Republic Aviation officials at dinner were discussing "the perfect fighter plane."

Listening attentively, Republic Vice President and Chief Engineer Alexander Kartveli drew an old envelope from his pocket and proceeded to sketch as the others talked and aired their ideas.

Based on this original sketch a design in more technical form was later submitted to the Army. And the answer came back—"Go to it!"

May 6th, 1941 saw the first flight of the Thunderbolt—the P 47 that is today using its terrific punch to drive Axis planes from the skies.

* * *

Up where Nature's thunderbolts are born, the P 47 carries its six tons of lethal might, with assurance and with confidence in the superiority of its weapons, its speed, its maneuverability and its ability to withstand attack.

Attack from the elements—as well as the enemy. For the precious skin of the Thunderbolt is guarded by Valspar Val-Aero Aircraft Finishes. Sun, water, temperature extremes—Nature is licked when it tries its tricks. Corrosion is banished—vital camouflage preserved.

Valspar is proud that it rides to Victory with the Thunderbolt!

VALSPAR
VAL-AERO

A complete line of dependable Aircraft Finishes —that meet Government specifications. • Valentine & Company, Inc., Eleven East 36th St., New York, N. Y. • Established 1832 • Makers of the Famous Valspar Finishes.

GRAND RAPIDS *Wood-Workers*

COMBINE SKILLED CRAFTSMANSHIP WITH LARGE VOLUME CAPACITIES FOR AIRCRAFT PRODUCTION

WOOD is playing a role of increasing importance in the production of aircraft. Calling for the highest kind of skilled workmanship, the exacting specifications and intricate assemblies have been "duck soup" for Grand Rapids craftsmen with their background of excellence in building fine furniture.

A Unique Set-Up

Grand Rapids Industries, Inc. — in no sense a "pool" — an independently financed *corporation* with its officers, management, sales, research, engineers, and production personnel and departments, correlates and manages under binding contract the facilities of its 15 Grand Rapids plants. Combining the large volume production capacities of these plants with the skills of experienced Grand Rapids furniture workers has proved a "natural" for the *precision* and *large scale* requirements of aircraft manufacturing.

Invasion of Sicily—attack led by GLIDER-borne troops on wings, many made by Grand Rapids craftsmen.

Diversification and Specialization

With the resources of 15 completely equipped and operating plants to draw on, *Grand Rapids Industries* has been able to diversify and yet specialize at the same time—allocating to each plant a specific job or part fabrication best suited to the individual plant's capacity. For this reason, production has been able to concentrate simultaneously on various aircraft assemblies, many precision parts.

How satisfactorily and efficiently this most unique set-up operates is seen in terms of

The precision specifications and intricate assemblies of wood required for aircraft are "duck soup" for Grand Rapids craftsmen with their background of excellence in making fine furniture.

Wings for the eyes of the Army — important assemblies for the Stinson L-5 liaison plane (the "flying jeep") produced in plants of Grand Rapids Industries, Inc.

results — results measured in terms of *output*.

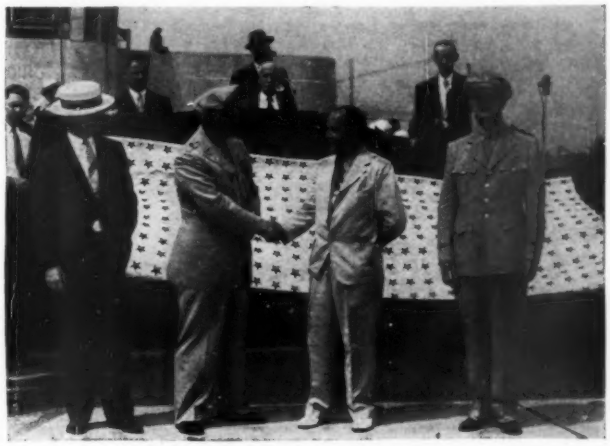
Proof . . . in the Air

Breaking all records in adaptability to new manufacturing technique, first orders were being delivered within 90 days after Industries was incorporated. Thousands of planes now in the air — the giant troop-carrying gliders that led the way in the invasion of Sicily, liaison planes, trainers, and mammoth bombers bear testimony to the versatility of production from the Grand Rapids plants.

Production for aircraft has included *complete wings* packed for shipment, floor boards, various sub-assemblies, tail surfaces, aileron assemblies, interior fitments such as bombardier and navigator tables, pilot seats, instructional instruments.

If it can be built of wood, Grand Rapids Industries can build it.

Grand Rapids Industries has made deliveries to, or is now producing vital wood assemblies or precision parts for, such leading firms in aircraft as Cessna, Timm, Curtiss-Wright, Stinson, Waco, and over 15 others — offers additional, quickly available, experienced production for whatever can be built of wood — solid or laminated — for the aircraft industry.



Serving on the fighting fronts as well as building aircraft — service flag of 472 stars was presented to employees of 15 plants of Grand Rapids Industries by Colonel Edward C. Black, commandant of the U. S. Army Weather School

Combining the skills of experienced wood-workers, with the large volume capacity and facilities of 15 complete, operating plants, Grand Rapids Industries has been able to diversify and yet specialize at the same time — simultaneously concentrate on various aircraft production jobs.

You are invited to communicate with

GRAND RAPIDS INDUSTRIES, Inc.

MONUMENT SQUARE BUILDING — GRAND RAPIDS, MICHIGAN

15 Plants Famous for Fine Furniture United in Production for the Aircraft Industry

Weather Goes to War

(*Continued from page 192*)

Thus bomber crews need medium and short-range weather forecasts in planning their operations so as to take advantage of clouds for concealment, while fighter squadrons—except when used as air support—must depart on very short notice and need only short-range forecasts.

Our airmen made clever tactical use of clouds in North Africa. In one attack, Stukas, escorted by Messerschmitts, approached an American target in the El Guettar area above a bank of clouds which concealed the planes from ground observation. The Stukas were to dive through the clouds, release their bombs and climb back into the safety of the concealment while the Messerschmitts continued a high patrol against intercepting fighters. The commander of the American fighter squadron, however, pulled the old mousetrap play. When the Stukas came down through the clouds, the Americans were right there to welcome them and the Messerschmitts up above never even knew the dive bombers were being knocked off.

"Weather planning," it now can be revealed, has aided AAF cross-channel missions as much as bombs. In one attack on Rouen, France, storm covered the area. The weather forecaster, however, predicted that a cold front would pass the city and would be followed by a narrow front of relatively fine weather with scattered clouds. The raid was timed to the second. Our bombers arrived over Rouen just as the front had passed, found their break in the clouds and accomplished their mission. Not a single plane was lost. American bombers repeatedly have followed such weather fronts into northern France without loss. Strong winds accompanying the front often have kept the smoke screen thrown up by the enemy from being effective.

The Flight Control Command's weather wing helps all of our armed forces to make the greatest possible use of weather. Much of the responsibility for planning such actions falls on staff weather officers attached to each higher headquarters. Each is an expert on the functions of his fighting unit and its weather problems. He receives forecasts, interprets them for his commanding officer, suggests weather "surprises," often sets the split-second timing when these will succeed best. It is his job to know exactly how fog, mud, rain and wind will affect the enemy. As the time for action approaches, he briefs fellow officers, forecasts specific changes in the weather and may even advise tactics to fit.

The work of weather units is highly routinized. It involves complex observations, computations, map and chart making and the assembly and revision of a maze of valuable records. Generally, commissioned personnel of the weather wing are administrative and supervisory officers. Enlisted men shoulder the tasks of observing and forecasting. Observers handle the preparation of maps and charts, observations and station maintenance while forecasters employ data collected by observers in the preparation of local, regional and national forecasts.

Good weather forecasts must be provided for the staff weather officer. Busy with his other duties, he has neither time nor facilities for detailed analysis. The station weather service fills the breach. Wherever the armed forces go, weather stations are established, providing forecasts and on-the-spot weather observations.

When an airfield is seized from the enemy and put to work for the Army Air Forces, the weather station is among the first organizations to set up shop. By the time a bomber squadron is ready to operate from the new base, the weather station is on the spot with up-to-date weather reports and forecasts for an area thousands of miles across. If a base must be evacuated, the weather station is the last service to go.

Weather observers of this war have seen combat duty on all fronts, in all climates. Coming ashore through the surf on North Africa with the first landing parties, they set up their stations under hostile fire. More than one unit has stuck to its post until enemy tanks were actually in sight. Because AAF weather men must pace or outstrip the fighting forces, most fixed weather stations are being converted to mobile units.

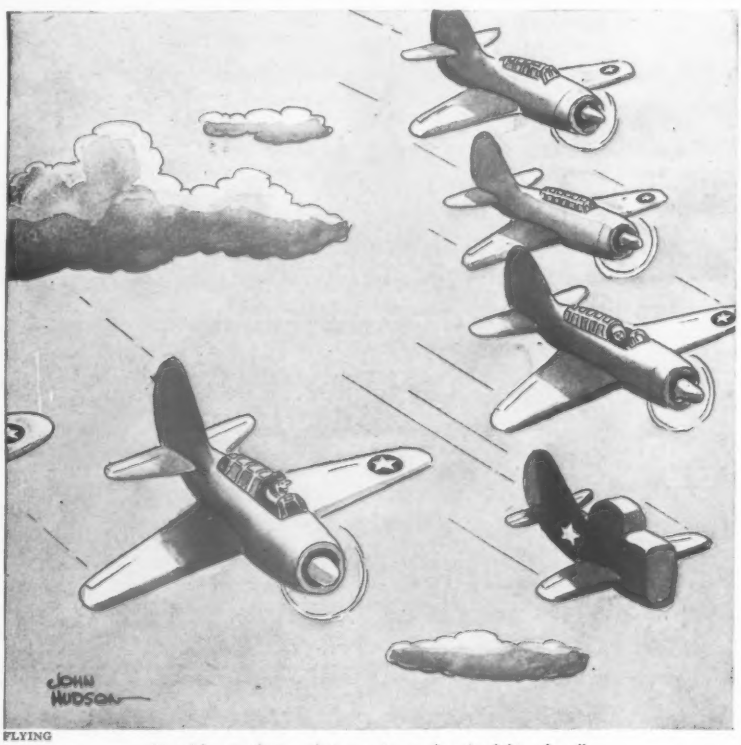
Weather stations, so vital to the effective operations of Flight Control, are geographically placed in an ingenious pattern to successfully cope with the flow of world weather. In a very broad sense, world weather moves from northwest to southeast in the northern hemisphere, and from southwest to northeast in the southern hemisphere. Actually, this is a loose pattern, modified locally by mountain ranges, large bodies of water and tracts of land, ocean currents and other geographical features. Weather stations, nevertheless, are set up to conform to this picture.

Weather stations are classified alphabetically according to the intensity of their service. Class A stations are posts for both forecasting and observing; Class B stations, usually located at Airways Traffic Control stations, provide only a forecasting service; Class C are observer posts and Class D are limited forecasting stations.

Each weather station is headed by a station weather officer who is a qualified forecaster. Under his direction, enlisted observers keep a detailed 24-hour-a-day record of all weather phenomena and transmit these observations, ciphered for security, to other weather stations and to central calling points for broadcast by radio. Every six hours special observations are made and distributed. Each station compiles hundreds of these reports on weather maps. Weather officers or specially trained enlisted forecasters analyze these maps and prepare forecasts for instant combat use.

The weather map is the most important and powerful tool of Weather Service. A complete map may contain re-

(*Continued on page 276*)



"I told you that cadet was 'way ahead of his class."

IT'S vitally important for America's future airmen to get off to a right start . . . with a good ship that answers to a finger's touch, a reliable engine and a prop that can take it. That's a hard-to-beat combination—especially when it's the Fairchild-Ranger-Sensenich combination as it is in the PT-19.

On the nose of the PT-19, or the PT-22, PT-23, PT-26, N2S-3 or wherever you find a Sensenich Propeller, you can be sure it's *right*. For Sensenich, world's largest manufacturer of wood propellers, knows how to make them right!

Right on the Nose of the Fairchild PT-19
PROPELLER TIPS
When swinging a propeller, give it a rotary motion—do not pull toward yourself.
• • •
Never "rev up" when the plane is standing on loose gravel, cinders or mud. Particles either picked up by the propeller or thrown against it by the wheels may cause serious damage.

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SENSENICH BROTHERS AIRCRAFT PROPELLERS, Adjacent to Lancaster Municipal Airport, Lititz, Penna.—West Coast Branch, Glendale, Calif.

THREE HEADS ARE BETTER THAN ONE...

• **Getting heads together,** as opposed to **knocking them together,** is the difference between our way of life and that which the Axis would impose upon us.

• We of Doak Aircraft are daily proving that **getting heads together** gets results. With perfect teamwork between worker, engineer and executive, our production schedules of vital aircraft parts and sub-assemblies have been set only to be exceeded.

• Such war production efficiency stems from ceaseless search for better ways of doing things. Even now, in the heat of the battle of production, we are **getting heads together** on applying that know-how to the needs of a brave new world to come.

DOAK AIRCRAFT COMPANY, INC.
TORRANCE, CALIFORNIA

WORKING AROUND THE CLOCK FOR A BRAVE NEW WORLD

The Flying Lathes of the Air Corps

One of the toughest jobs of the Air Corps Technical Service is to get disabled planes back into the air when they have been forced down in remote locations. No matter where the plane is grounded, skilled technicians must get there quickly with all the tools and equipment required to make emergency repairs.

Buy War Bonds!

Precision machine operations are sometimes required—so the Air Corps is prepared to fly a Precision Lathe wherever a plane can land. Packed in special, lightweight cases and fitted with accessories for doing a variety of work that would surprise you, these flying lathes are an important part of the Air Corps' emergency service equipment.

We are proud that South Bend Lathes have been selected for this important service—one of many vital assignments that are keeping South Bend Lathes busy for the duration.

SOUTH BEND LATHE WORKS

SOUTH BEND, INDIANA **LATHE BUILDERS FOR 36 YEARS**

NAMES the U. S. must never forget

AERONCA
AIR CRUISERS
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BOWLUS
BREWSTER
CESSNA
COMMONWEALTH
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CULVER
CURTISS-WRIGHT
DOUGLAS
FAIRCHILD
FLEETWINGS
FLETCHER
FORD
G & A AIRCRAFT
GENERAL MOTORS
GOODYEAR
GRUMMAN
HOWARD
INTERSTATE
LOCKHEED
MARTIN
★ McDONNELL
NORTH AMERICAN
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VEGA
VOUGHT SIKORSKY
WACO

...in planes—parts—plastics

SWINGING THROUGH doors marked "Production" or "Engineering" in many a leading aircraft plant you'll see keen-eyed technical men whose boxes or briefcases bear the words "McDonnell Aircraft Corp." Competitors? No—they're "co-operators"—the long arms of McDonnell reaching for tough jobs wherever airplanes are built.

How well they've done their jobs is a story that can be told only in part . . . till after victory. But many an abstruse math problem, many a handy piece of aircraft equipment, many a plastic weight-saver bears the McDonnell trademark.

Another of the names that stands for hard work, so the U.S. may have—not the "best" airplane, but a *right* airplane for every job, McDonnell and its brand of pioneering and planning and production promises to loom large in the Air Age to come.

SUBCONTRACTING a Big Load

LIKE THE HUNDREDS of units of the aircraft industry, pulling together to do a big job well, a length of Roebling aircraft control cord "sub-contracts" its multi-ton load and divides it among more than a hundred fine steel wires that make up the cable. We make sure that every wire "cooperates". *Aircord Division*, John A. Roebling's Sons Company, Trenton 2, New Jersey. Branches and warehouses in principal cities.

JR ROEBLING

*In these frequent messages, Roebling salutes each member of the aircraft industry in turn.

ROEBLING

means Control in the air

(*Continued from page 272*)

ports from several hundred stations. Reports must be obtained from nearby and friendly areas and from the most remote lands and seas, friendly or not.

Arctic weather stations are outposts sending back weather reports from the all-important regions where cold waves have their beginning. The Army Weather Service is training Arctic explorers wholesale for this lonely, dangerous work. Every man selected is a volunteer and must be physically perfect. At special Arctic training camps they learn how to live off the country, what hazards the far north will pose, how to overcome them. Small groups of two to five men, with a cook and a scout, are transported by airplane to their assigned post with a winter's cache of supplies. From then on, their only contact with the rest of the world is by radio or through an occasional airplane bringing in supplies.

How do these men feel about their work?

One group is typical.

Five men and a non-commissioned officer had spent most of last winter at a station far north of Labrador. The first airplane to bring them mail in the spring brought a routine letter from their regional control officer, addressed to all stations, requesting volunteers for "isolated duty in the "Far North." To a man, the five isolationists sent back their reply with the next plane: "We want to volunteer. This job is simple—we want to see something really tough." In a war without frontiers, these men may see duty on an ice floe at the North Pole.

Other reports reach the weather map from remote tropical islands and from ships stationed at sea. Berlin has complained about weather reports reaching the United Nations from Norway!

Such teamwork is not one-sided.

Weather dictates ground and sea operations, independently or teamed with air power. When the French attacked northwest of Kairouan in North Africa, storms had chained all aircraft to the ground. The French took advantage of drifting mountain fog, rain and strong winds to drive the Germans from two mountain strongholds. With visibility zero they isolated enemy outposts, surprised them one by one.

Britain's famed Eighth Army chose similarly violent weather when it struck a strong enemy line at Fondouk in the midst of a raging dust storm. Clouds of dust swirled around and between the German bunkers, which the British dispatched in turn. A similar dust storm enabled American troops to bring up their 155's to within close range of German armor at Djebel Perda—an artillery victory not seen, but felt, by the routed enemy.

Halfway around the world, one man who could praise "bad" weather was the commander of a Naval task force which slipped by night into Kula Gulf in the South Pacific. This task force by-passed the Jap Base at Kolombangara, got clean away by ducking into rain squalls so soupy that no enemy plane could follow.

Reports also reach the weather map from the stratosphere, higher than even the newest bombers and fighters fly. These reports are sent back by radio from tiny observing and transmitting apparatus carried aloft by hydrogen-filled balloons. These almost human midget weather stations are called radiosondes. They take the place of the old weather planes which used to disturb the morning slumber of peacetime citizens. Before the war, the Weather Bureau operated about 30 radiosonde stations in the United States, now needs more than 200 such stations in areas where the AAF is operating.

Radiosonde has a big brother, too. This is the automatic weather station, a complete little weather observer and self-powered radio transmitter which can be left on a mountain top, set up on a remote island, or dropped by parachute behind the enemy lines. It will transmit regular reports of the weather, each station having its own cipher, for six months.

Relatively new in scientific forecasting are weather reconnaissance planes, specially equipped. These range far into enemy territory, make careful observations hundreds of miles behind frontiers and add many a detail to station weather maps. A long-range aircraft also precedes an important flight of small craft on a long hop, exploring cloud layers and wind conditions at various levels. Keeping a few hours ahead of the main flight, the weather reconnaissance ship radios back warnings of icing or strong head winds, suggests a change of course or altitude for safety.

Officers of the intelligence service also do their bit for the weather map by questioning our raiding crews after a foray over enemy-held territory. These officers compile such information and forward it to weather officers and flight control centers for immediate use in guiding other bombers over the same route.

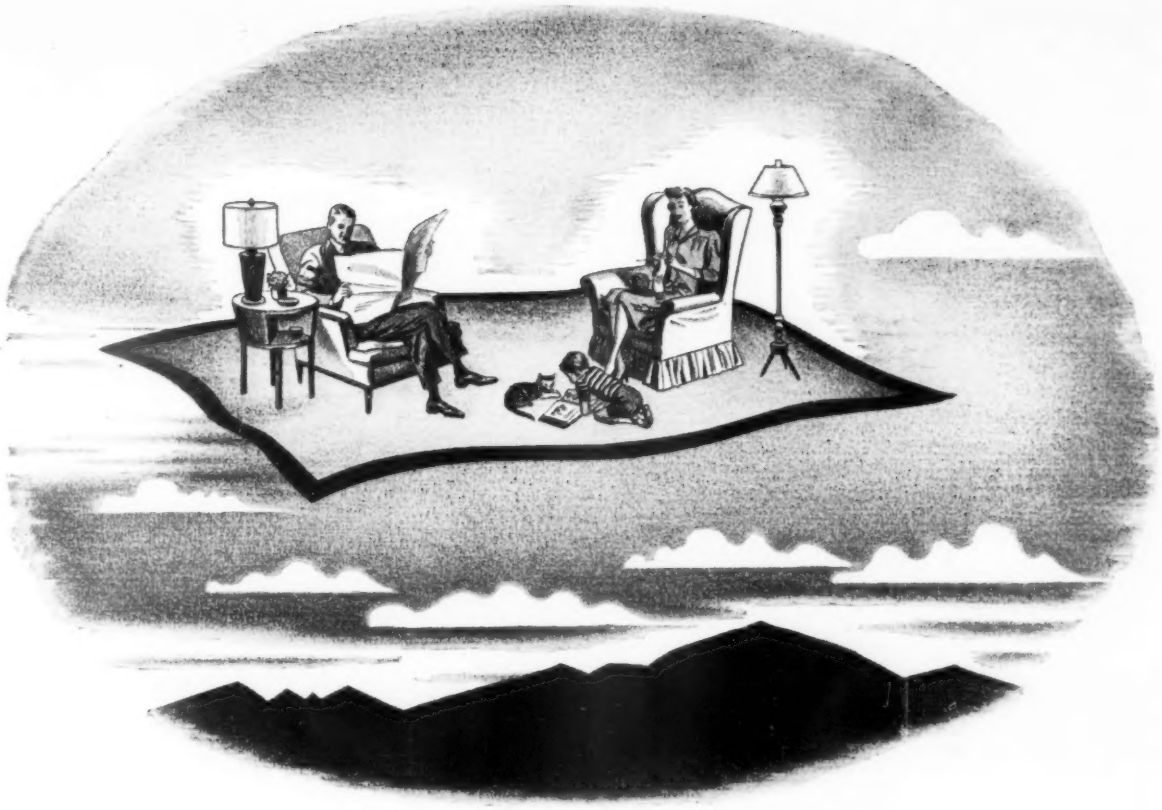
War has neutralized one of the most important peacetime sources of information—ships at sea. For reasons of security, these reports have been silenced for the duration. This fact is one reason for persistent United States attacks against Jap bases in the Aleutians, where much Pacific weather originates.

There would be many gaps in AAF weather maps were it not for the splendid co-operation among all branches of the armed services, the airlines, and the Government weather services of the United States, our allies and the few remaining neutrals. Reports are continually exchanged. Communication facilities are shared.

The rapid wartime growth of the Army Weather Service has fostered an enormous training program. Revolutionary advances in the sciences of meteorology laid one more burden on personnel. Training had to begin almost from scratch, with few qualified instructors available and but a small number of civilian institutions equipped to teach this subject.

A few years ago only a score or two of meteorologists were being trained annually at American universities. Today we are training thousands of weather officers and many more thousands of ob-

(*Continued on page 284*)



Picture you at 20,000 feet . . .

flying in living room comfort

You are in a postwar airliner. You are flying high above the storms...in air nearly twice as thin as at sea level . . . in cold as low as minus 50° F.

Yet you're not the least dizzy. Your ears don't pop. You are as comfortable and relaxed as in your own living room!

This is not a dream. It is definitely the kind of air travel comfort you can expect in the AiResearch-pressurized cabins of postwar airliners.

AiResearch engineers have been on this project since long before the war. In our giant "Stratolab," they've created "altitudes" as high as 65,000 feet, temperatures below minus 90° F and air that is eight times more rarified than on earth!

Extreme conditions, yes; but these engineers have learned to control them. With the AiResearch-pressurized cabin, they will literally maintain a low altitude inside an airliner's cabin while the plane travels above 20,000 feet!

And in the peacetime days that are ahead, our ever-widening experience with air control will contribute to your better living *on the ground* as well as in the *skies*. Keep AiResearch in mind. It is one of the newer trade names you're going to learn to know well.

AiResearch
MANUFACTURING COMPANY
LOS ANGELES • PHOENIX
DIVISION OF THE GARRETT CORPORATION

"Where Controlled Air Does The Job". Automatic Exit Flap Control Systems • Exhaust Heat Exchangers
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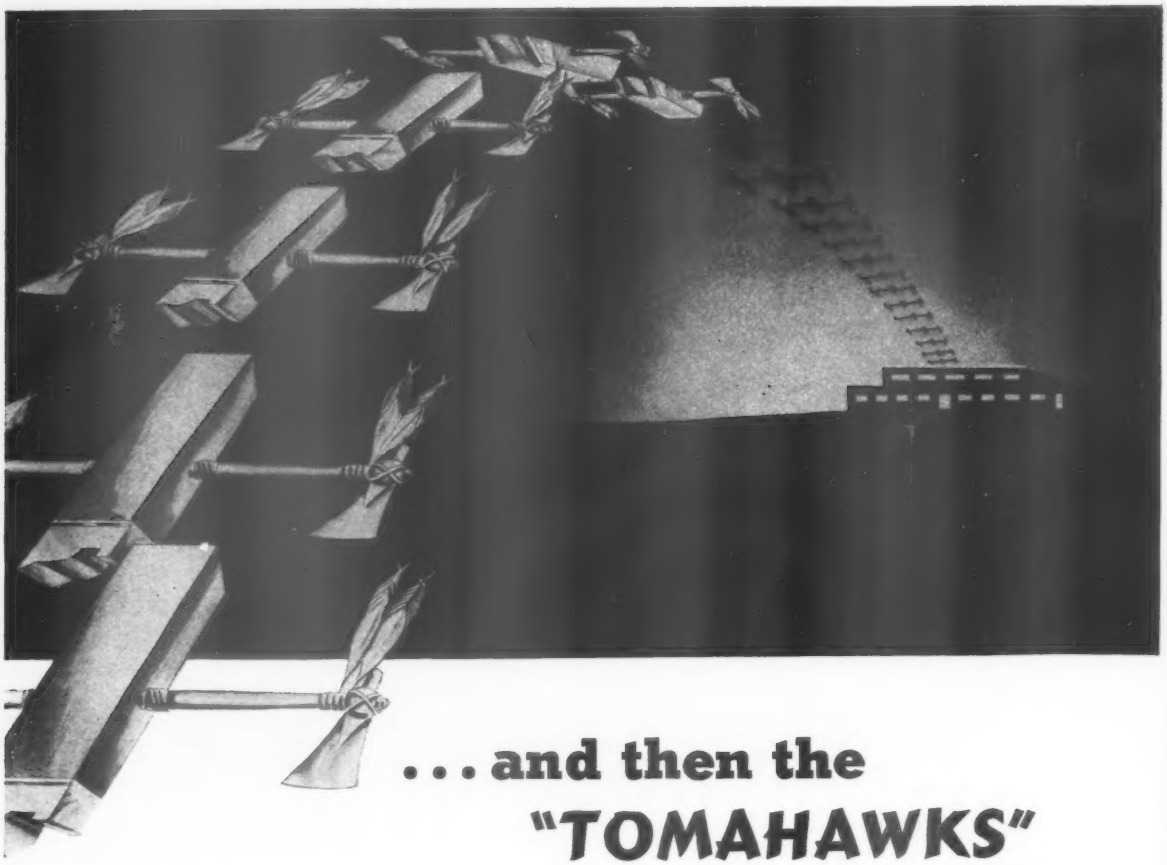


. . . and then the "TOMAHAWKS" came a-flying

YOU'VE READ many stories about how the Tomahawks licked the ME-110s, the Focke-Wulff 190s and Tojo's Zeros. But the chances are you've never heard how **"TOMAHAWKS"** helped to win one of the war's biggest battles.

These Tomahawks were not the Curtiss fighter planes known to every schoolboy of the United Nations, but Genesee **"TOMAHAWK"** cutting tools which — on the production front—have helped to win our first big battle, the battle of production.

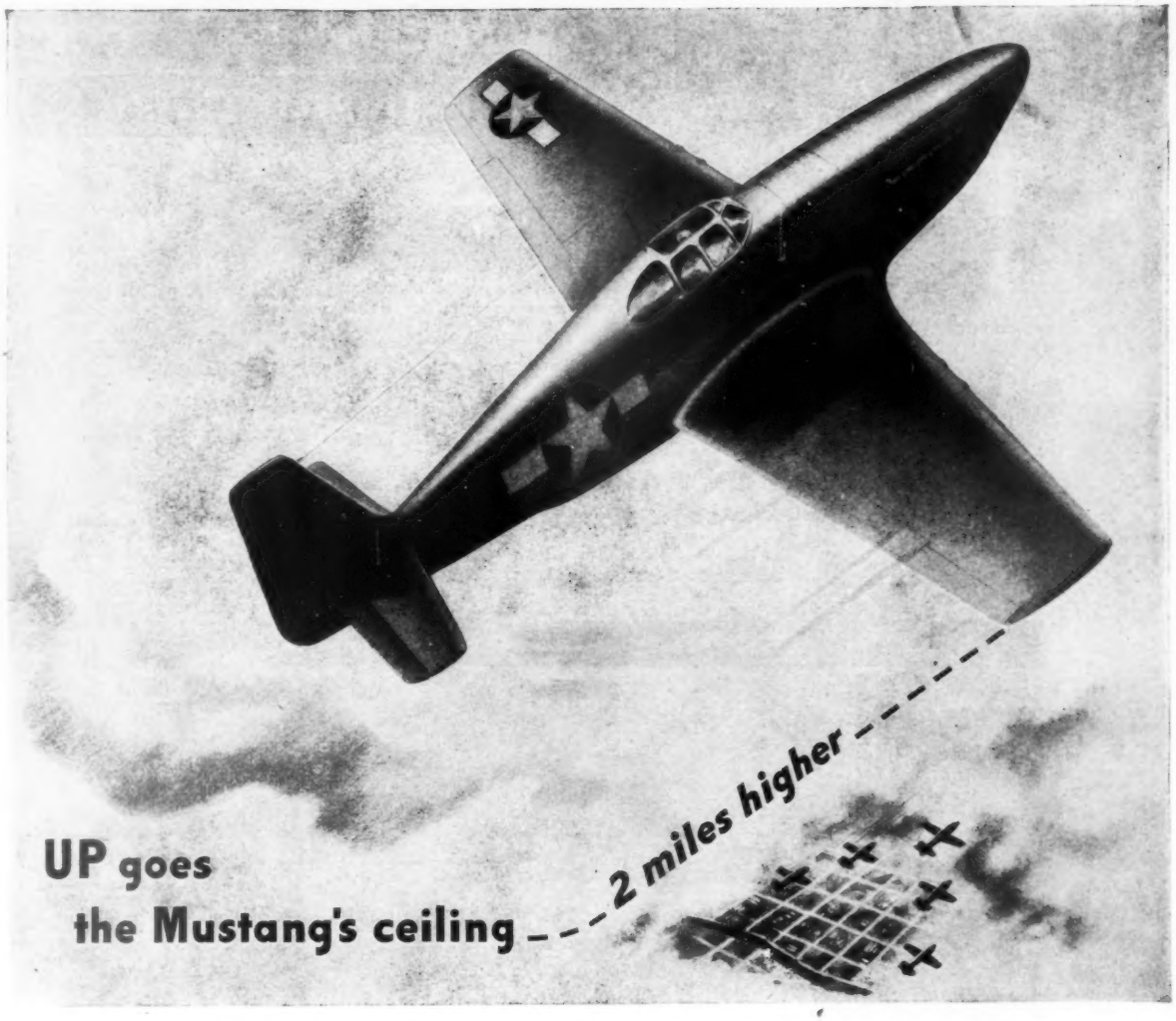
These Tomahawks have come a-flying by the thousands and tens of thousands out of Genesee's three plants in Michigan's little town of Fenton. They tackle the toughest babies in the way of steels and bronzes and aluminum. Their pilots have not always been experienced—but these **"TOMAHAWKS"** like their flying namesakes have kept on and are keeping on cutting away, day after day and week after week—as part and parcel of the greatest production offensive success the world has ever known.

There is another battle Genesee has been helping to fight: The War on Waste. Its poster series—free to metal working plants in war industry—has been teaching workers the importance of conserving the vital materials used in cutting tools.

GENESEE TOOL COMPANY

FENTON, MICHIGAN

* Registered Trade Mark



THE BOYS WHO'VE been flying the bullet-like North American Mustang say it's one of the Army's hottest fighters.

Time and again, though heavily outnumbered by the enemy, they've turned in spectacular box scores.

Imagine, then, what these hell-for-leather American fighter pilots are going to do when they get an even *hotter* Mustang—an even *swifter* Mustang—a Mustang they can push upstairs into the thin high air *farther* and *faster* than they ever could before.

And that's exactly what they're going to get!

For this superb plane is now being powered by the Packard-built Rolls-Royce engine, with a new supercharged surprise: *British and Packard engineers have found a way to skyrocket the Mustang 2 miles higher than its effective fighting ceiling used to be!*

Two more miles of blue sky for Mustang pilots to fight in!

To make this possible, Packard has added engines for the Mustang to its mass-production output—another contribution to the finest fighting Air Force flyers in the world!

PACKARD *Precision-Built Power*

ASK THE MAN WHO OWNS ONE

MUSTANG fighter | WARHAWK fighter | HURRICANE fighter | LANCASTER bomber | MOSQUITO fighter-bomber | NAVY PT boats

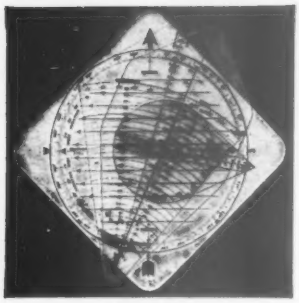
Jardur ★ AVIGATION INSTRUMENTS, ACCESSORIES & BOOKS!

★ SPECIAL PILOTS' PRICES!

JARDUR SUPER FLIGHTMASTER

World's Finest Air Navigation Computor—All Vinylite Construction

For Primary or Advanced Pilots. The most complete automatic precision air navigation computor ever designed. Solves every known problem accurately, quickly and easily. Instantly provides a mechanical solution for basic problems assisting in the visualization of each. Maintains all data until solution is reached avoiding all errors.



Reverse Side

LIST $30.00
NEW LOW PRICE $15.00 Each, Postpaid

Unlike other computors solutions do not have to be obtained by use of pencil drawings. All printing is permanent, large, easily read in a poorly lighted plane, will not wear off. Includes every range of ground and air speeds, wind velocities, temperature, elevation, etc. REQUIRES NO ADDITIONAL INSTRUMENTS.

This patented 6 inch computor has an exclusive folder circle construction of ground and air segments providing the degree of accuracy of a 12 inch instrument. Every part is made of heavy durable fire and weather proof vinylite. Will not shrink or warp. Mechanically it will last a lifetime.

HERE IS WHAT THE SUPER FLIGHTMASTER WILL SOLVE:

1. Correction for Wind. 2. Drift Angle. 3. Running Fix. 4. Wind Determination by trail angle and drift. 5. Wind Determination by Observation. 6. Wind Determination by Double Drift. 7. Wind Determination by Zero Drift. 8. Ground Speed Trail Angle starting at zero. 9. Ground Speed Trail Angle Regular. 10. Radio Determination of Distance to a Station. 11. Radio Determination of Distance Out. 12. Correct for Drift—by triangulation. 13. Correction for Drift—stated in degrees. 14. Correction for Drift stated in distances. 15. Radius of Action by Calculation. 16. Radius of Action by Triangulation. 17. Radius of Action—Alternate Base. 18. Radius of Action—Reconnaissance. 19. Critical Point. 20. Moving Base—Out. 21. Moving Base—Home. 22. To convert a true course to a compass course. 23. To convert a compass to a true course. 24. Gain or Loss in Altitude. 25. Rate of Climb or Descent. 26. Time of Climb or Descent. 27. Conversion of Indicated Altitude to True Altitude. 28. Conversion of Indicated Air Speed to True Air Speed. 29. Estimating Time of Arrival. 30. Conversion between statute miles, nautical miles and kilometers. 31. Distance—Given Time and Speed. 32. Total Gallons—Given Time and Gallons per Hour. 33. Time—Given Distance and Speed. 34. Time—Given Total Gallons per Hour. 35. Speed—Given Distance and Time. 36. Gallons per Hour—Given Total Gallons and Time. 37. Typical Problems involving Distance, Speed, Gallons, per Hour and Time.

The Above List Includes All Dead Reckoning Problems in Use Today.
Supplied in a genuine leather case with complete instruction book.

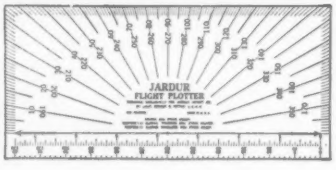
★ OTHER ESSENTIAL JARDUR ACCESSORIES ★

FLIGHT CALCULATOR

New Model "H"—Just Out. With this double-faced calculator, pilots can easily and accurately determine the true ground and air speeds. Tells speed at any given temperature and altitude. Variation and Deviation. Index angle. Course corrections. Wind velocity—temperature—speed—distance—and gas consumption. Dead reckoning and solution of many other problems. Takes in every range of ground and air speeds—wind velocity—temperature—elevation—etc. **No additional instruments required.** Coated for permanency. Clear, large, quick reading scales and dials (5½" diameter). Has strong container, with instructions.

Made of Grafoid: List $2.00, Your Cost $1.00 ea. Postpaid.
Made of Acetate (Lifetime Use) List $4.50, Your Cost $2.50 ea. Postpaid.

Still available a small quantity of our popular model "V" Calculator which is similar to our Model "H." Does not include new extra features nor Time Summation Disc, in Model "H." Strong container. Durable Varnished, Grafoid (4½" diameter).
List $1.00
Your Cost 50c Each, Postpaid



JARDUR FLIGHT PLOTTER

Designed by Lt. Comdr. Ernest G. Vetter, U.S.N.R. An accurate, versatile instrument, 3¾x8". The large numbers and two color scales are easy and quick to read. Used only two ways on a map and only one set of figures can be read in either position. Made of Durable, non-inflammable Cellulose Acetate. All printing protected. Determines true course, measuring distances, working wind triangles of triangles of velocity problems and reciprocals. Incorporates sectional and regional scales and 7½" of straight edge (1/16" divisions) besides 360° protractor. Strong container with magnetic variation map, complete instructions.
List $2.00
Your Cost $1.35 Each, Postpaid

JARDUR SMALL AREA PLOTTING CHART

Simplifies preparation of small areas. Provides accurate small area plotting chart based on Meridional parts from Bowditch table V. Promotes accuracy by providing largest working area for solution of problems. Heavy paper on both sides, size 13⅞x12½".
Per Pad of 25 Sheets 75c, Postpaid

JARDUR COURSE PLOTTING SHEET

Very useful in laying out navigation flight plans. Heavy paper, size 8½x11".
Per Pad of 50 Sheets 65c, Postpaid

"FIELD OF ACTION OF AIRCRAFT"

Including Radius of Action, by W. W. Smith, Chief Engineer, Jardur Import Co. Based upon discovery of a NEW METHOD of solving radius of action problems, so simple in application, that under any given set of conditions a determination can be made for ALL directions to flight from the base in a few minutes. This total determination we call the "field of action." The matter is presented in logical order and clear concise form. Easy to read and understand. Pilots and Navigators will find that book opens a new field in aerial navigation, as IT IS THE FIRST TO COVER "Field of Action" problems, 64 pages (8½x11") of valuable information. Illustrated with 30 large working drawings.
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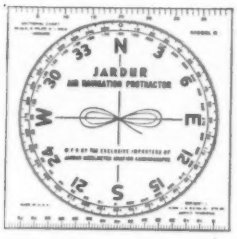
JARDUR AIR NAVIGATION PROTRACTOR



This string type 360° Compass Course Protractor is invaluable for laying out course, measuring wind drift angles, distances, Radio-range bearings, etc. Rules on the ends of the protractor calculate the distances on Government Sectional and Regional Charts. Compass and Rules are scaled very accurately. Made of tough, transparent, non-inflammable Cellulose Acetate, 5" square. Extra Long Non-raveling silk string. Reciprocal scale eliminates interpolations.
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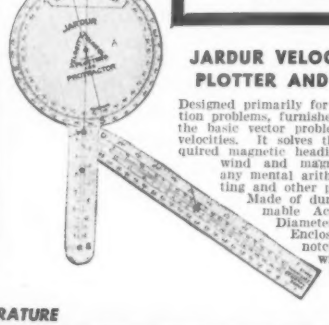

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Designed primarily for plotting aerial navigation problems, furnishes automatic solution to the basic vector problem namely, triangle of velocities. It solves this problem to the required magnetic heading, correcting both for wind and magnetic variation without any mental arithmetic. Useful in plotting and other problems.
Made of durable heavy non-inflammable Acetate. Handy size. Diameter 4½" by 8½" long. Enclosed in strong thumb-notched carrying container with complete instructions.
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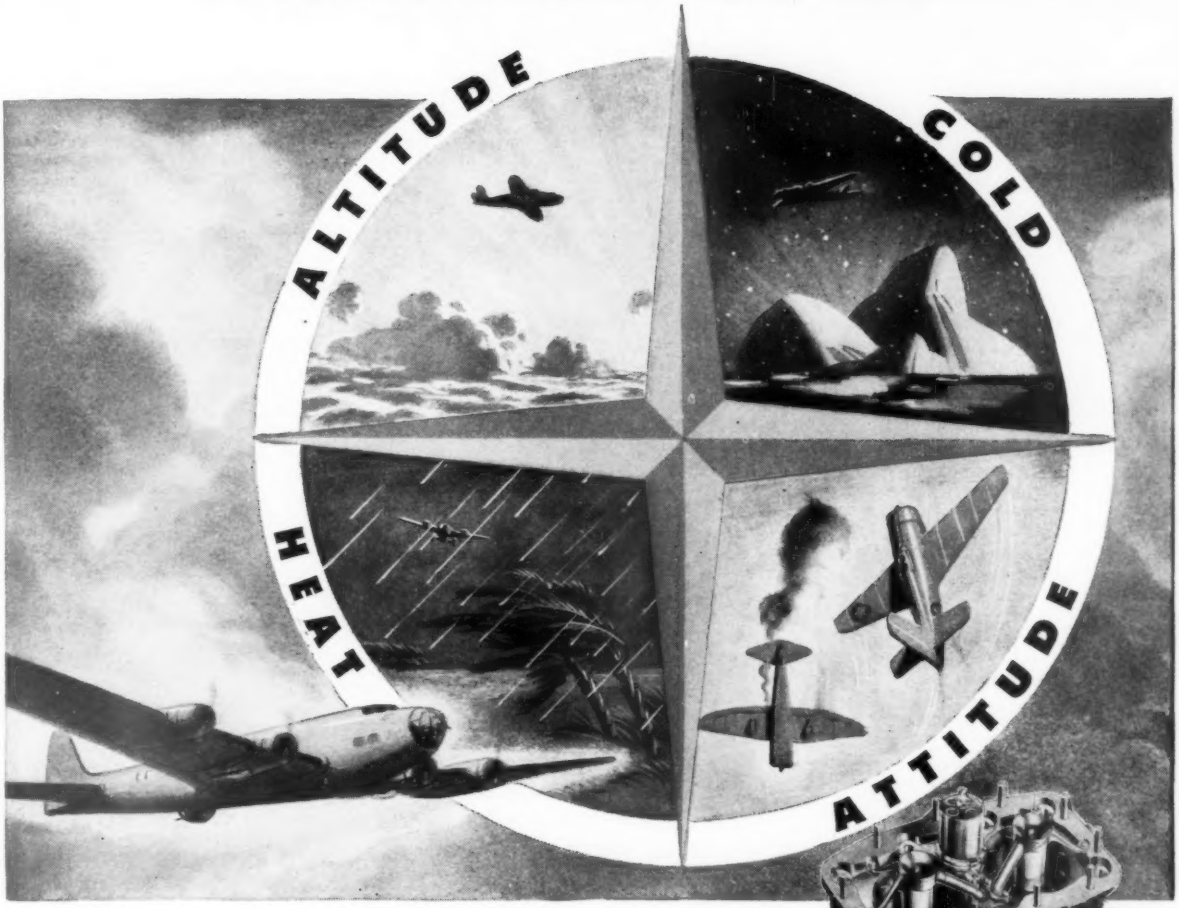

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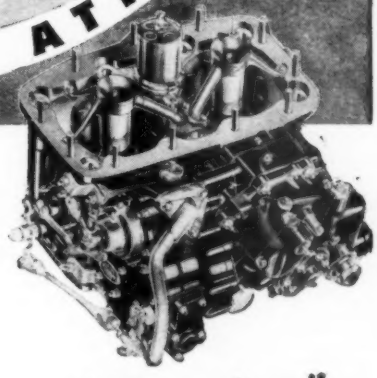
COMPENSATES INSTANTLY AND AUTOMATICALLY

Whether it's a swift rise upstairs from blistering-equatorial heat to sub-zero cold, a power dive on an enemy carrier, or the sudden bank of a fighter plane in a dog-fight,—"Stromberg" Injection Carburetion dependably meters fuel with mathematical accuracy in proportion to air. Combining automatic metering with positive pressure-atomizing of the fuel spray, the "Stromberg" Aircraft Carburetor compensates instantly for all changes in conditions of flight. In pace with each amazing development of engine and plane designers, Stromberg engineers study the lessons of both laboratories and battle fronts to keep "Stromberg" Carburetors *as great as the ships in which they fly.*



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The "STROMBERG" Aircraft Carburetor is an important member of "The Invisible Crew" . . . precision instruments, and controls, which Bendix plants from coast to coast are speeding to our fighting crews on world battle fronts.

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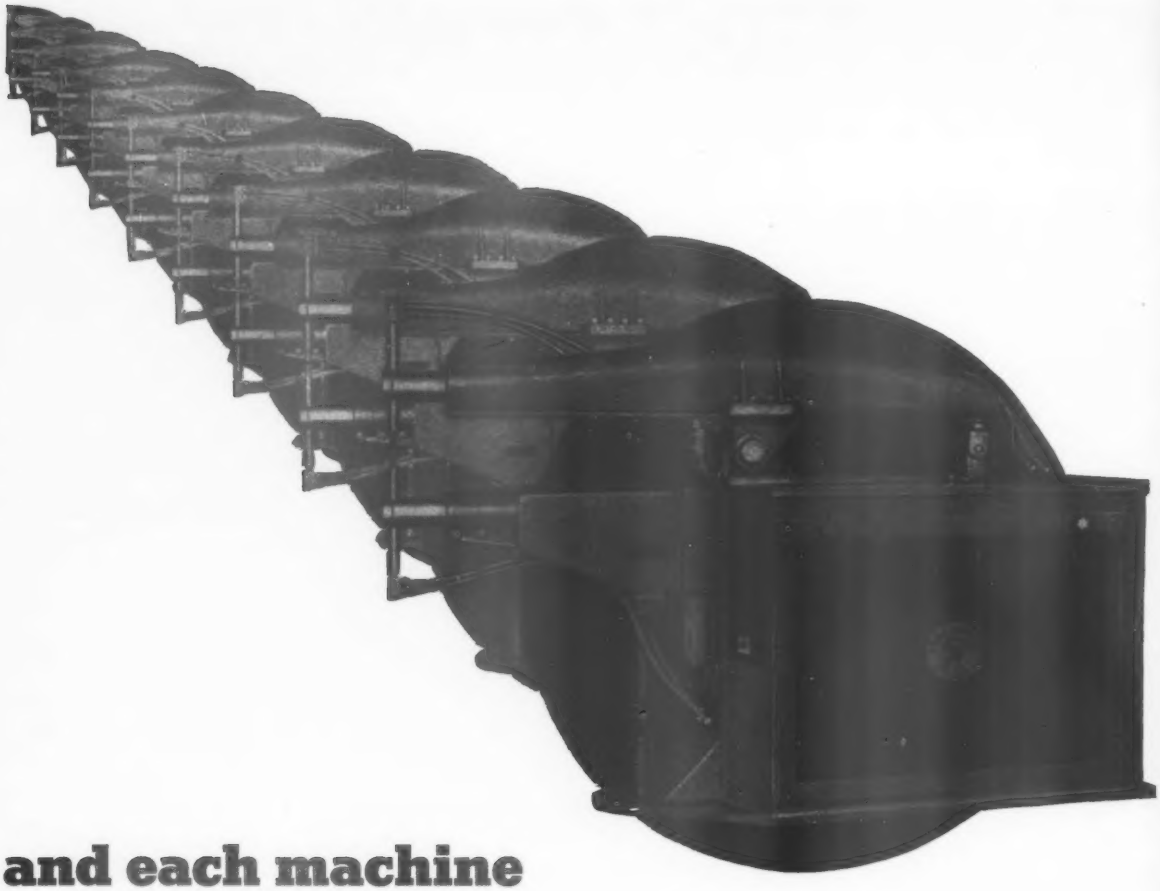

and each machine will *Save* 15,000 to 30,000 *Rivets* every day

ALTHOUGH we have turned out more planes faster than any nation on earth ever did before, this is only the beginning.

Tomorrow you'll see airplanes, better airplanes, RESISTANCE WELDED airplanes, coming off those lines in numbers yet undreamed of.

Here is one reason: Progressive's Rocker Arm Welder for Aluminum (shown above) has passed every qualification test and is eliminating—in production—tens of thousands of punching, drilling, reaming and riveting operations—plus the rivets themselves—every day.

We are proud to be building equipment like that—on a production line basis—at Progressive.

For further information on Progressive's latest Rocker Arm Welder for Aluminum, send for Bulletin No. 102.

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MILITARY airmen know that this is the day of *specialized* planes . . . designed to do specialized jobs. Some planes are best for ground-strafing . . . others for medium-level fighting . . . and so on.

Our back yard is the stratosphere. The Republic Thunderbolt is built to fight at 35,000 feet and up. It protects high-flying bombers.

Powered with a 2,000 horsepower engine, the Thunderbolt flies at more than 400 miles an hour. Its turbo-supercharger assures greatest efficiency in the rarified upper air.

The stratosphere is the strategic area . . . the ceiling . . . of today's global air war. Because of the higher speeds it permits . . . and its freedom from turbulent weather . . . the stratosphere will be the favored path of tomorrow's high-speed transportation. Thus, the high-flying Thunderbolt anticipates happier things to come.

Republic Aviation Corporation
Farmingdale, New York—Evansville, Indiana

REPUBLIC *Aviation*

FARMINGDALE DIVISION

SPECIALISTS IN HIGH-SPEED AIRCRAFT

(*Continued from page 276*)

servers and enlisted forecasters. Because of the highly technical character of modern weather analysis, each of these men must have a working knowledge of algebra, calculus, differential equations, vector analysis, fluid mechanics and other specialized studies. The war-busy Army Air Forces absorb all qualified applicants.

Weather training of enlisted men is handled in an observers' school for three months and a forecasters' school for six months. Upon graduation from these schools, men are sent to any one of hundreds of weather stations in the United States. Trained weather experts are permanently assigned at bases in the U. S. or overseas.

Schooling for officers consists of three courses. Under the "A" program, officers attend weather school for nine months at one of five universities where this training is offered. The "B" course consists of a six months' preparatory curriculum on any of a dozen campuses.

Other colleges fill in with the "C" course. Depending upon the amount of his weather background, a student may take either the "B" or the "C" course first. Before he may be commissioned, he must have completed the "A" course.

The Weather Wing conducts intensive research at Washington, D. C., at Massachusetts Institute of Technology, University of Chicago and at many other centers. Here meteorological data for each theater of war is tabulated, analyzed and dispatched to Army units. END

We Study the Enemy

(*Continued from page 190*)

nese planes also is undergoing tests. German equipment has been found far superior to that in use by the Japanese and also compares favorably with the equipment used by the Allies.

Japanese radio has shown that it lacks any real effective range. It is cheaply made and reception is poor. By comparison German radio equipment comes in at almost any range equal to our own; reception is extremely good and it is well constructed.

Careful study by the various laboratories of radio, instrument and electrical systems resulted in two outstanding findings in both German and Japanese aircraft parts. Experts in the Instruments and Navigation Unit found a small refinement on a Jap automatic pilot which, being applied to our new types, has improved their efficiency. A small diagram on a piece of electrical equipment explaining its operation was found on a German plane, and this diagram is being added to a similar piece of equipment on our planes, aiding maintenance.

Various types of oxygen equipment, including Japanese, German and Italian are also under observation. Of the trio the German devices seem to be the most efficient, though they do not come up to our own systems. This probably accounts for the difficulty enemy ships have in getting up to the extremely high altitudes—an accomplishment that they only recently have been able to attain.

Although little Italian equipment is under observation there is enough to indicate an interesting design trend—a flair for trim and glaring display. The Italians decorate their instrument panels with a galaxy of glaring colors, and one set of captured machine guns had chromium-plated handles.

The Japanese pilot's uniform, taken from a pilot shot down over New Guinea last February is made of cheap material—both leather and lining—and its wiring system is comparatively simple although effective. The electrically-heated boots are sufficiently warm but they are made of cheap leather and are stiff and uncomfortable. It was again evident that the Japs are interested in training their men to know their machines—for inside the little suitcase where the Jap pilot carried his excess clothing was a detailed diagram of his suit so that he himself could fix anything if a mechanism should fail.

On the other hand, the German electrically-heated suit is of the best quality. It is lined with a velvety material, is soft and warm. It is virtually "covered" with a series of zippers which make it easy to remove, indicating there is no shortage of zippers for the German air force.

Hundreds of other items, from a spark plug to a complete engine, have been shipped to Wright Field, and some have come half way around the world. END

☆

A SALUTE

TO THE THOUSANDS OF RANKIN TRAINED PILOTS WHO ARE SERVING THROUGHOUT THE WORLD TODAY

J. G. TEX RANKIN
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RANKIN AERONAUTICAL ACADEMY

RANKIN FIELD • TULARE, CALIFORNIA

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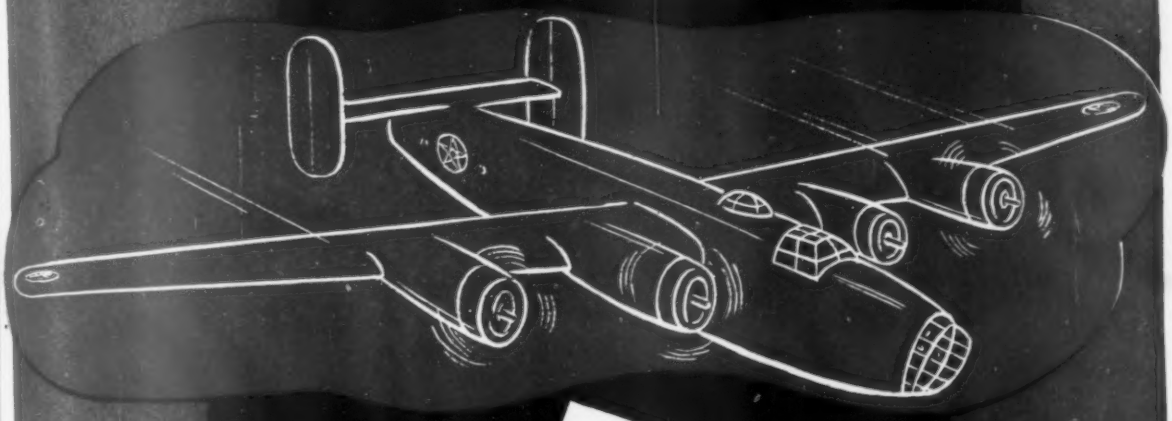
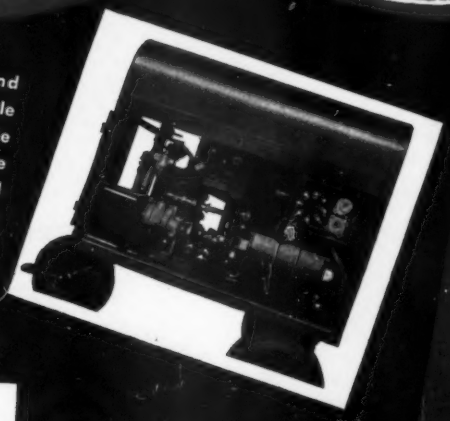
Exclusively LELAND

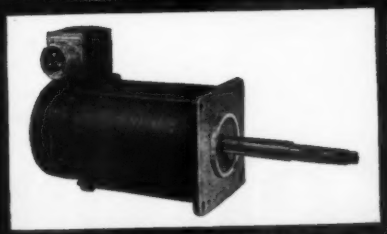


For the air services Leland developed, and are the sole builders of, the adjustable speed AC-DC motor on the accompanying truck. It is used to power aeroplane instrument testing equipment—driving a hydraulic pump to produce pressure—can be found at all air bases where power is available.



Also developed for the air services by Leland and being built exclusively by Leland, is the accompanying aircraft power inverter. This unit finds its application on planes where it furnishes high frequency alternating current to power automatic pilots, radio compasses and other electronic devices in aviation.

The third Leland unit here shown is an aircraft type DC motor used to operate landing gears.



Leland engineering and Leland plant facilities are geared for war production and you, perhaps, may find at Leland the solution of some design or supply problem now troubling you.

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THE LELAND ELECTRIC COMPANY, • DAYTON, OHIO

Maker of Air History—

The North American B-25

Part of the wiring assembly of North American's B-25 Mitchell Bomber.

ANOTHER PLACE

WHERE BELDEN WIRE GOES TO WAR

These swift, deadly B-25 Mitchell Bombers, built by North American, are active above all the world's major battle fronts. The fourteen-ton giants have unloaded bombs on the enemy from Tokyo to Tobruk —from Russia to New Guinea.

Here is another example of the way American ingenuity is winning the war. Here skilled workers, using service-tested materials, have produced a weapon that stays "on the job." Here is another place where Belden wire goes to war!

Back of Belden aircraft wire is a lifetime of experimenting and testing—collaboration with aircraft engineers since flying was in its infancy. This vast experience makes possible the Belden wire that meets today's needs.

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Wiring the pilot's switch box. Altogether, miles of wire are used on the B-25.

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Starter, Lighting, and Instrument Cables √ √ √ SPARK PLUG WIRES

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There is no substitute for leather... and in the aviation industry there is no need for one. But to avoid waste, use the leather tanned especially for the job it has to do.

Our job is supplying these leathers to exact specifications to meet the many vital industrial needs of today. More than this, we are prepared to help engineers and purchasing agents solve their specific leather problems. Our agents and leather experts in all principal cities are there to serve you... call on them. Write for or check the items that interest you and mail the coupon below.

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▶Because leather breathes it is used in the aviation industry as grease boots.

▶**Some leathers remain soft, flexible and usable for an unlimited time at a temperature of minus 70° Fahrenheit.**

▶By actual test, our special oil tanned leather in ⅛" thickness has a maximum tensile strength of 6714 pounds per square inch.

▶**Leather is far superior to any other material for upholstering purposes.**

▶Leather can be furnished to withstand grease, gasoline and water, thereby remaining flexible under all conditions.

These are just a few of the facts pertaining to our aviation leathers.

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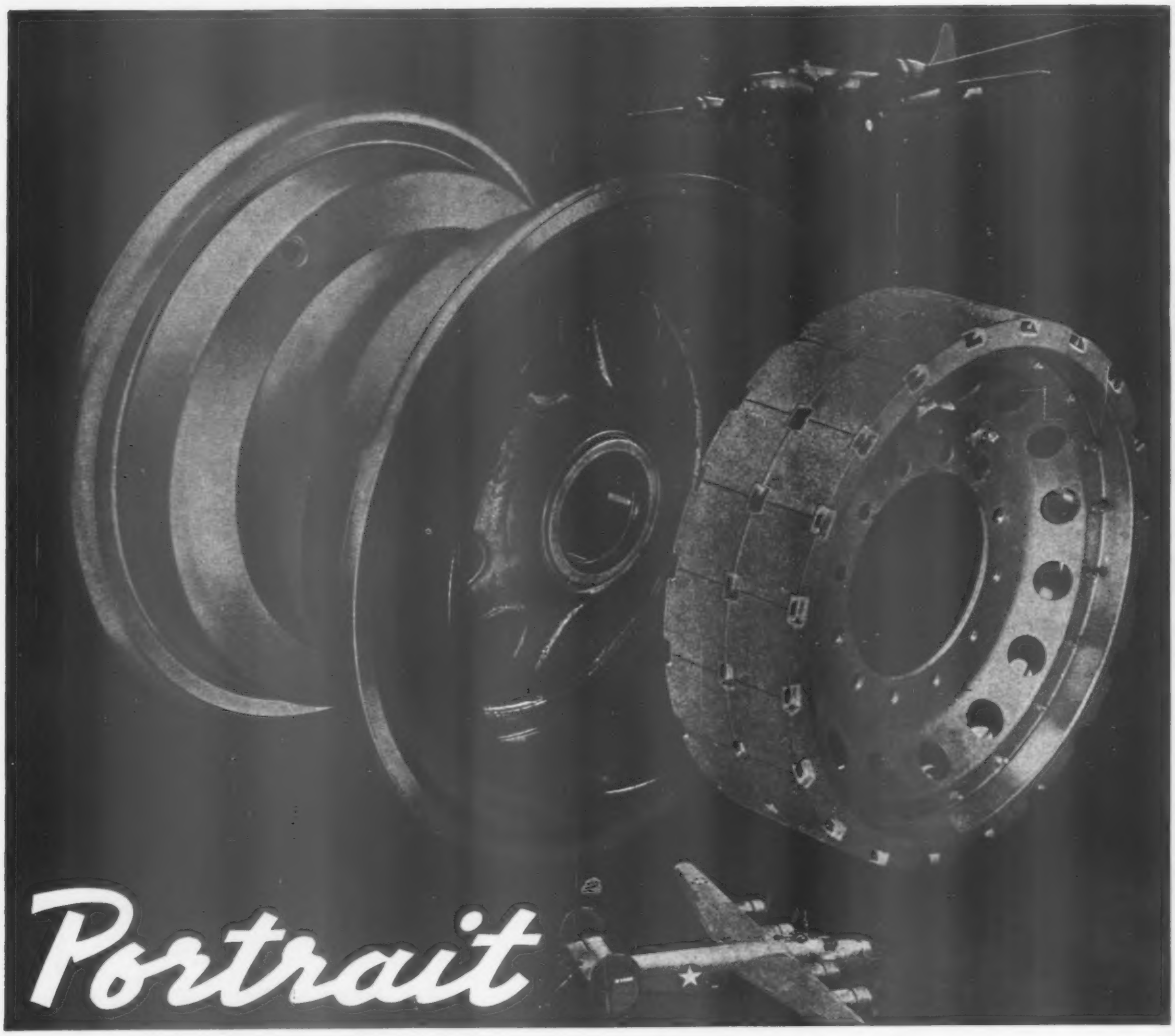

OF A "CREW MATE" THAT STARTS A FLIGHT . . . AND ENDS IT

"THE PORTRAIT" *Hayes Aircraft Wheel and Expander Tube Brake as used on the C-46 and other ships. Boeing B-17 Flying Fortress and Consolidated B-24 Liberator (illustrated) are also Hayes equipped.*

Slugging fight or routine flight—Hayes Wheels and Brakes mean accurate ground control in getting the ship off and landing it . . . last to leave the ground and first on the return.

War-tested in combat and training, as well as by the Air Transport Command and nation-wide airline operators, Hayes Wheels and Brakes rate "E" for Economy and Efficiency — in low maintenance cost, low cost per landing, stamina under punishing operation, ease of maintenance in the field—as well as accuracy of control under the gruelling ground variables of sand, steel, concrete or snow.

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Harwood AN connectors are used by most leading aircraft companies as well as by principal instrument companies and many others.

Elimination of one coupling nut and one barrel results in a lighter and more readily installed plug with consequent substantial saving in time and cost of installation. • This simplified plug, entirely of diecast construction, conforms to Army-Navy specifications. • A complete range of Harwood connectors in AN specifications from sizes 10S to 48 is offered—all backed by years of engineering experience in the connector field.

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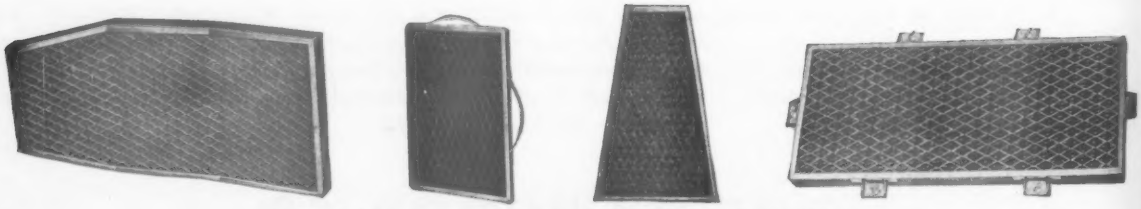
protect the engines *that take 'em there and bring 'em back!*

● In Sicily, Australia, and all other fronts where dust menaces our flying forces, airplane motors equipped with AAF Filters stay *continuously on the job 10 times as long as* those without filters!

Dust—due to make-shift and temporary air fields in combat zones—is a vital problem of maintenance at the front, just as it is a major problem of manufacture in the production of planes and war materials at home. In airplane and machine tool plants, ordnance works, armories, foundries, synthetic rubber and plastic plants, etc., AAF Dust Control equipment has proved itself essential to all-out production.

More than twenty types of AAF airplane engine filters are being made today for United Nations' planes. These were developed in cooperation with aircraft engineers to meet varying airplane construction requirements as well as Army Air Corps specifications. Write Dept. F for complete information and performance data.



A few of the twenty-three types of AAF Airplane Engine Filters

AMERICAN AIR FILTER COMPANY, INC., LOUISVILLE, KY.

★ AUTOMATIC PILOTS, DIRECTION FINDERS, DRIFT INDICATORS

★ ELECTRONIC FOLLOW-UP DEVICES, TORQUE AMPLIFIERS AND CALCULATING DEVICES

★ WING PANELS, TAIL EMPENNAGES

★ MAJOR AIRCRAFT ASSEMBLIES

★ WELDED ASSEMBLIES—GAS, ARC AND SPOT

★ ENGINE COWLINGS, SPEED-RINGS, NACELLES, EXHAUST COLLECTOR RINGS AND EXHAUST MANIFOLDS

★ WING PANELS, TAIL EMPENNAGES, STRUTS AND MAJOR AIRCRAFT ASSEMBLIES

★ AIRCRAFT PARTS

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★ AUTOMATIC SCREW MACHINE PRODUCTS

★ "STEADFAST" TRANSCEIVERS, COMPASSES AND WALKI-TALKIES

★ "UNITIZED" RADIO RECEIVERS

★ AIRCRAFT ENGINE PRE-HEATERS

★ OIL AND GASOLINE TANKS

★ GUN MOUNTS, AMMUNITION BOXES AND CHUTES

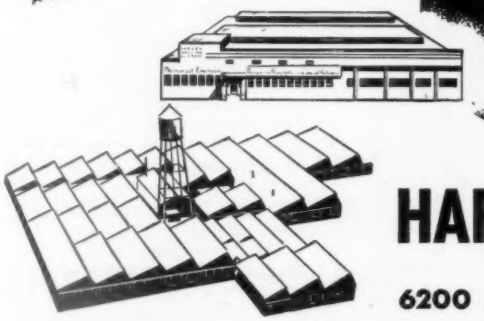
HARVEY PRODUCTS HELP *Sight 'em* and *Sock 'em!*

Our fighting men *find* the enemy first with the help of Harvey electronic equipment—*hunt* them out in planes, tanks and ships the Harvey company helped build—and *sock 'em* harder with equipment produced in the modern Harvey plants.

Now, the various divisions of the Harvey Machine Company are delivering vital war equipment of widely different types to the United Nations fighting forces in every corner of the world. To meet the faster delivery rates demanded for our equipment, production has been stepped-up many times—faster than is the average for all industry.

Today every man and machine in the huge Harvey plants is working at top speed to supply and equip our Armed Forces . . . but we invite inquiries on any production problem or product that will help win this war.

Plans are already made by which Harvey developments will become outstanding contributions to commercial aviation—when the war is won. Developments now in military use, and others not yet announced, will make flying still safer, faster, and more efficient in years to come.



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DIVISIONS ★ ORDNANCE ★ SPECIAL MACHINERY ★ ELECTRONICS

17—and the AAF

(*Continued from page* 151)

easier it will be for you and the Army Air Forces later on.

The next thing is to get tough. Physically tough. Probably you already have the Victory Corps at your high school. Today, physical fitness means more than playing games and keeping out of a sickbed.

Physically and mentally, you're "in training" for the biggest job a 17-year-old ever took on.

It's not merely for yourself. In a war that means teamwork wherever the United Nations are slugging the enemy, *you* will be part of this team. Other men will depend on your stamina, just as you'll depend on theirs. Fitness is your responsibility. Others can suggest training programs, hours of sleep and clean habits. What you do about it is squarely up to you.

If you're wise, you'll be finding out about the Army in general, the Air Forces in particular. You can study aircraft identification, read the war news, check an atlas for the name of every harbor and factory town mentioned in the newscasts.

That no future airman may be missed, here is what the AAF says about who may fly:

An applicant for appointment as aviation cadet for air crew training must have reached his 18th birthday but not have reached his 27th birthday.

For the 17-year-old who has qualified for enlistment in the Air Corps Enlisted Reserve, appointment may come on his 18th birthday.

An applicant may be single or married.

Birth certificate or other proof of date of birth or citizenship must accompany all applications.

An applicant must have been a U. S. citizen for at least 10 years before the date he applies. There is one exception, however: A citizen of an Allied nation, who qualifies in all other respects, may request the adjutant general of the War Department to waive the 10-year citizenship requirement.

An applicant—for voluntary induction or for enlistment in the Air Corps Enlisted Reserve—must present three letters of recommendation from reputable citizens who know him well, but who are not relatives.

When you are called for active duty, on or after your 18th birthday, you're in the grade of private in the AAF and assigned to an Air Forces Technical Training Center. This is where you first get basic training as a soldier and learn the fundamentals of military life for five weeks.

Then, if you're like most high school graduates, the AAF packs you off to college before you even have a look at an airplane.

Under the college preparatory preflight training program, aviation cadet candidates are enrolled as enlisted men in one of several score colleges and universities throughout the country for a five-month preparatory course, prior to being assigned for flight training in schools of the Training Command.

Impatient to fly, you doubtless are chafing at the thought of school days when planes are waiting.

Yet, everyone entering the Army Air Forces has to go to school.

To meet the responsibilities of training specialists for history's greatest war, this branch of the armed services has inaugurated one of the greatest educational programs in the history of the United States. There is a school to meet each need of the AAF. Each member of the Air Forces, officer or enlisted personnel, has to attend the school that will:

1. Fit him for his duties.
2. Refresh his earlier training and experience.
3. Enlarge the training he had on entering the Army to serve best his country, his unit and himself.

The AAF five-month school program already has proved itself in training wartime airmen.

This training includes the five weeks of basic instruction as a soldier before the 20-week course at one of 154 colleges and universities throughout the country. Two more weeks at an AAF classification center determines whether a man is best fitted for bombardier, navigator or pilot training.

If you wonder why the AAF spends five months training a man in ways that seem far from flying against the enemy, just remember this is a smart man's war. We never have claimed to be "supermen" in America. But we're developing the world's most complex air weapons—planes and guns and bombs that are hurling back the enemy and crashing in the Axis roof.

We're long on precision, we Americans. We don't bomb for terror or to kill women and children as a means of victory. We blast the war-making centers of the Axis wherever found, a job requiring all the scientific skill of a problem in mathematics.

Once you have aviation's special brand of mathematics and physics under your belt, you're prepared to know why a plane can fly, how far it can range on its gas capacity, what the effect of a certain tonnage of bombs will be on a specific target. Flying might still be high adventure to you, but it's primarily a job to be done. The better we do the job the quicker we'll win the war and get on with the world-wide job of flying that will open up peacetime careers for millions.

For this reason your five months on the campus are five months of the most concentrated training you'll ever know. It is

(*Continued on page* 295)

FLYING

"Pulling the lever is all we expect of a bombardier!"

Ultimate Source of Altimeter Accuracy

As fine chronometers are set by Observatory time, Pioneer* Sensitive Altimeters must be calibrated to exact barometric standards. Ultimate source of their accuracy is the Master Barometer shown.

This Pioneer-built instrument uses an oil-diffusion and a mechanical fore-pump to create above the mercury column the highest practical vacuum. With back pressure thus reduced to an infinitesimal value, readings are taken by a sensitive cathetometer to within .002 mm. Pioneer Standard Barometers, calibrated from this master, control the testing of Altimeters at all stages of manufacture.

This masterpiece of equipment design exemplifies the superior shop and laboratory practice behind the precision-performance of Pioneer Instruments. Eclipse-Pioneer Division, Teterboro, N. J.

THE PIONEER ALTIMETER

is precision-built for accuracy and permanency of calibration. It is an important member of "The Invisible Crew" which 25 Bendix plants from coast to coast are speeding to our fighting crews on world battle fronts.

PIONEER INSTRUMENTS

THE INVISIBLE CREW

Precision Equipment by Bendix AVIATION CORPORATION

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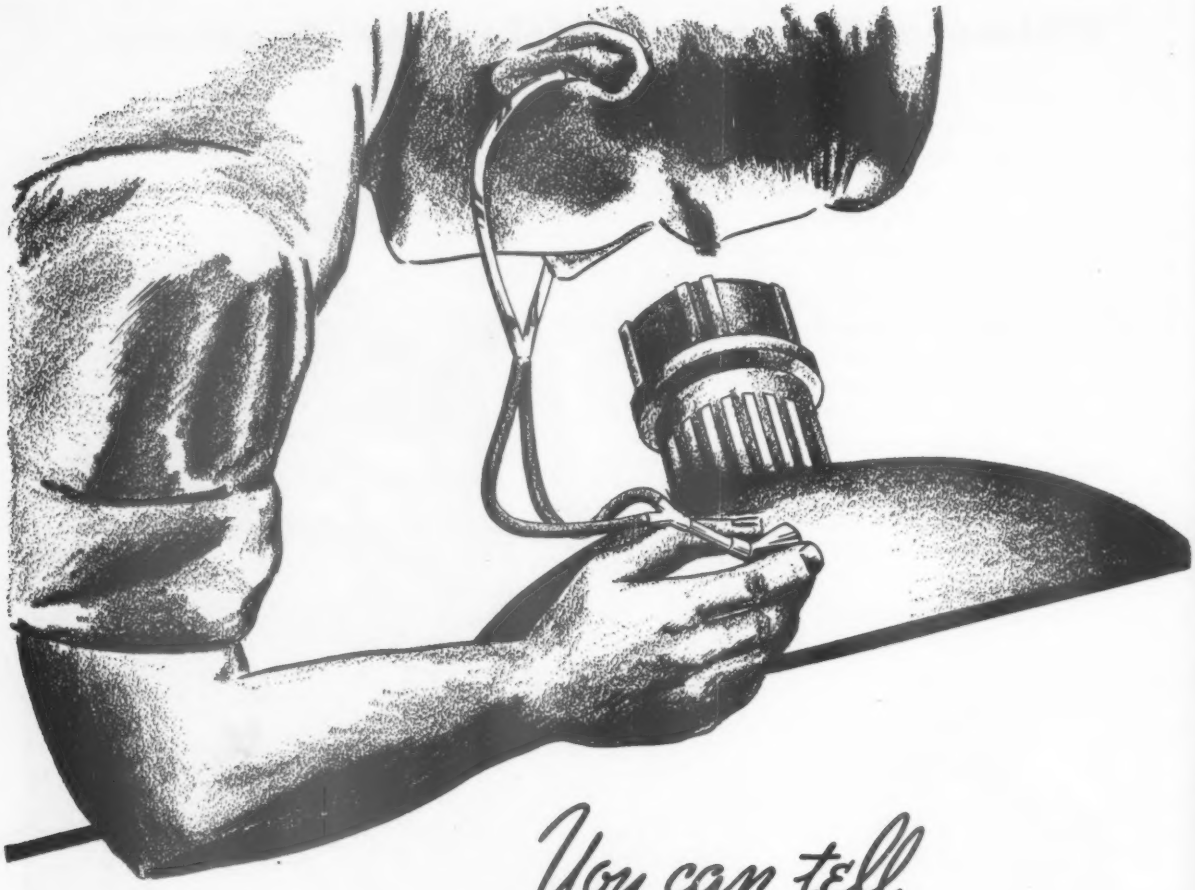

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by the noise it Doesn't make

You can take hours in putting a beautiful polish on an inaccurate gear–but it won't make that gear any more accurate.

The best test for gear quality–and that means gear life–is not how pretty it looks but HOW QUIET–accurate–it is.

And the fact is that "MICHIGAN" SHAVED GEARS *ARE* QUIETER even though you need less time, less equipment, less skill, and less money to finish a gear to the desired accuracy on a Michigan than by any other method.

Ask for the new Gear Finishing Manual #GF-43

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BUY U.S. BONDS STAMPS

MICHIGAN TOOL COMPANY

7171 E. McNICHOLS ROAD . . . DETROIT, U. S. A.

(*Continued from page 292*)

neither dull nor "playboy" stuff. Class work is skillfully balanced by military training and rugged team sport. You'll even fly several hours, and understand—thanks to physics class—why you take off at a certain speed and why you can do only so much in a low-powered plane.

Your academic training includes not only mathematics and physics, but global geography, modern history and English.

Since geometry and physics existed before aviation, and aviation is based on their principles, you will get no diluted "quickie" course but the fundamentals every adult should know. You'll study time and weights, curves and angles and slide rules.

Because of what you learn in physics you'll respect weather as an ally to be studied. You'll understand generators, the force of gravity and the fundamental principle of the bombsight.

You'll study geography, but not in the old ways. The air age has revolutionized all our concepts of time and distance. Map reading of the *round world* will prepare you for the world airways you'll be flying. Knowing about the climate and industry and natural resources of the warring nations will show you how wars happen, but aviation geography will point the way to post-war trade by air.

Even English is specially tailored for airmen-to-be. You'll have to know how to talk intelligently with people the world over, but you'll also have to speak and write the airman's language—a technical one involving regulations, plane design and firepower. You'll need to *know* these things—and to explain them to others.

A 24-hour study of Civil Air Regulations is aimed at making you a smarter airman, right from the start.

Military indoctrination, under AAF instructors, includes both classroom work and drill. You'll have to know the customs of the service—our own and our Allies'. Courses in hygiene, sanitation and medical aid give you a preview of conditions you'll have to face in the tropics, the desert and the Arctic.

In 10 hours of dual instruction, you'll begin to learn flying itself. This comes during the fifth month on the campus, and takes you through the maneuvers of a light training plane—straight and level flight, turns, banks, stalls, spins and landings. There will be landing practice, traffic pattern flying and rectangular courses. When you go on to elementary flying school you'll be practically ready to solo.

Fresh from college, you'll go to an AAF classification center which determines the kind of airman you'll be. There's another tough physical exam. There's more military training. Most important, all sorts of "screening" tests—based on AAF experience with thousands of trainees during many years—find out what makes you tick.

Specifically, the AAF can discover even before you're in an airplane whether you'd make a pilot, navigator or bombardier. Whatever the result, if you pass these tests you're headed for aviation cadet training. END

THE EXECUTIVE WHO STOPS TO THINK . . .

Knows that "10% for War Bonds isn't enough these days"

Workers' Living Costs going up . . . and Income and Victory Tax now deducted at source for thousands of workers . . .

Check! You're perfectly right . . . but all these burdens are more than balanced by *much higher* FAMILY INCOMES *for most of your workers!*

Millions of new workers have entered the picture. Millions of women who never worked before. Millions of others who never began to earn what they are getting today!

A 10% Pay-Roll Allotment for War Bonds from the wages of the family bread-winner is one thing—*a 10% Pay-Roll Allotment from each of several workers in the same family is quite another matter!* Why, in many such cases, it could well be jacked up to 30%—50% or even more of the family's *new* money!

That's why the Treasury Department now urges you to revise your War Bond *thinking*—and your War Bond *selling*—on the basis of *family* incomes. The current War Bond campaign is built around the family unit—and labor-management sales programs should be revised accordingly.

For details get in touch with your local War Savings Staff which will supply you with all necessary material for the proper presentation of the new plan.

Last year's bonds got us started—*this year's bonds are to win!* So let's all raise our sights, and get going. If we all pull together, we'll put it over with a bang!

This space is a contribution to America's all-out war effort by
ZIFF-DAVIS PUBLISHING COMPANY
540 N. Michigan Avenue
Chicago, Illinois

you've done your bit
. . . now do your best!

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

VICTORY'S MARGIN MAY BE FEMININE

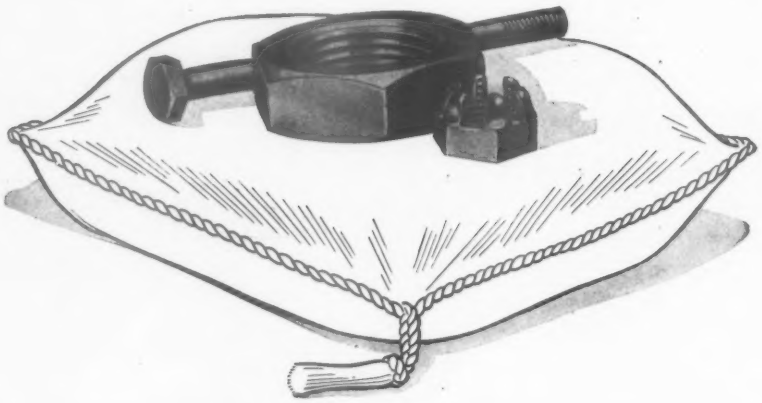
Long since have we given up the idea that men alone can both fight and supply a global war. Clearly is this visible at Solar. Increasing numbers of women workers are assuming increasing importance in the production of "anti-monoxide" exhaust systems for the fighters, bombers and cargo airplanes of the United Nations. Well may it be said that on the production line, Victory's margin may be feminine.

ARMY E NAVY

SOLAR

EXHAUST SYSTEMS—

SOLAR AIRCRAFT COMPANY ★ SAN DIEGO, CALIFORNIA



You've said "NUTS" to us for 11 years

When you Aircraft Manufacturers have said nuts, or bolts, or turnbuckles—it meant they were needed *quick*. So "Same Day Service" became our policy.

You seemed to like that. Our business grew. When aircraft production zoomed to meet the straining demands of war, Supply Division kept pace—expanding, growing—always maintaining its original policy of speedy service on all shipments. Hundreds of thousands of man hours undoubtedly were saved by having needed parts reach production lines on time.

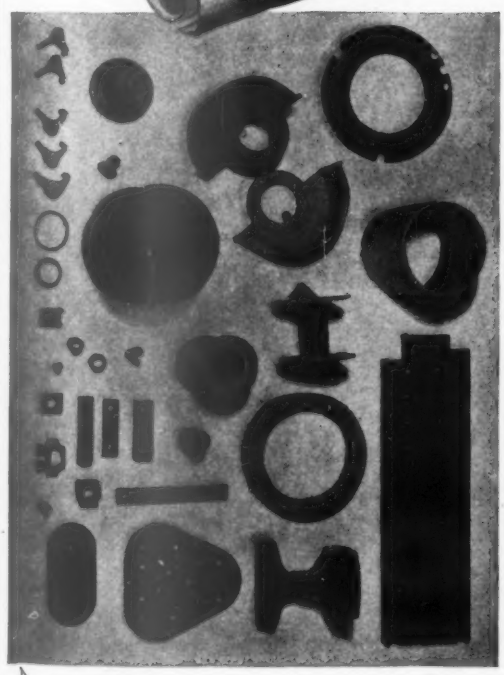
To maintain that kind of service, we have had to expand still further. Two warehouses are now in operation—a third is under construction. We like to feel that these efforts are assisting in bringing nearer the day of Victory.

And when it comes, we would like to feel you will continue to depend upon this Company for all the help it can give in solving the problems that will challenge you in the period after Peace.

SUPPLY Division Inc.
LAMBERT AIRPORT ROBERTSON, MO.

LAMBERT AIRPORT,
ROBERTSON, MO.
PHONE: TERRYHILL 5-2902 (ST. LOUIS)

208 W. GRAND AVE.,
OKLAHOMA CITY, OKLA.
PHONE: 3-6224



When a parachutist takes his final exam both his diploma and his life depend on the fitness of his rip cord.

Lives also frequently depend upon the fitness of inconspicuous radio and electrical parts of Formica laminated plastic used in war equipment — such parts as insulating spools, insulating spacers, breaker arms, radio tube socket bases, terminal strips, rheostat cores and other insulating parts.

Formica combines lightness with strength, dimensional stability, and resistance to change through chemical action. It has a low power factor, low dielectric loss. There is a wide variety of grades each of which emphasizes some one of the many valuable properties of material for special purposes.

THE FORMICA INSULATION COMPANY

4628 SPRING GROVE AVENUE • CINCINNATI, OHIO

Radio

(*Continued from page* 195)

One of the latest German radio units is that in the Heinkel He-111H reconnaissance plane, as well as the newest long-range bombers. Installation includes a long and short wave two-way communications system having four pre-tuned frequencies. There also are a direction finder, instrument landing equipment, interphone, inter-aircraft circuit, and emergency radio for forced landing at sea.

Without efficient radio and its allied developments, the airplane can not promptly report what it sees. Its orders cannot be changed. It is denied vital navigation aids. It cannot be properly directed in battle.

Information on the enemy obtained by aircraft must be transmitted instantly to higher headquarters, where it may decide operations and may far outweigh in real value the damage of bombs.

AACS furnishes information on the arrival and departure of military planes and their positions in flight. It transmits latest weather data to ground stations and aircraft in flight. All modern aids to navigation—radio ranges, direction finders and ultra-high frequency beacons—are operated by the Communications Wing.

Communications had to develop specialized equipment for operations in remote regions, established units in parts of Alaska, Africa, and Asia where such scientific activity had before that time been unknown.

This is an example of actual AACS operation: a flight of planes, carrying materiel and skilled personnel badly needed at a fighting front 10,000 miles away, is being readied for take-off somewhere in the United States. Its commander already knows what weather to expect. The Communications Wing has co-ordinated up-to-the-minute reports from observers hundreds of miles apart as basis for its forecast.

Flight plans are quickly completed. The planes depart with safety and precision under the traffic direction of an airport control tower. Word is flashed ahead to their first destination for servicing arrangements.

The planes soon cross a "leg" or "course" of the communications radio range, and swing down it, the pilots knowing that so long as they continue to hear a certain repeated signal in their earphones they are "on the beam," headed straight for their goal.

The aircraft arrive at an airport near the coast and are guided to the ground by another of the system's control towers. A repair crew is waiting to work on one of the planes which developed engine trouble en route and has radioed its plight and an estimate of the repairs needed.

Checked and refueled, the planes take off again, this time over open ocean. Their next destination is a mere dot on the sea. There are no landmarks to help here. But the pilots have their course and compasses and are methodically following the predetermined route when, suddenly, the radio silence is broken.

Flight Control warns that a storm has made up in the path of the flyers and is moving towards them. They are told how to avoid it: to swing south a number of miles. This they do, and arrive safely at their goal.

From the time each plane moves out to taxi from a landing field until it is parked at its destination, it is under continuous radio control. Air-ground positions are constant. The plane must report its actual time of departure position at various times en route, weather changes encountered during flight and must vary its ETA if storms or head winds threaten to cause delay.

Every plane must send an operational message to each place over which it will fly or at which it will stop. Aircraft warning, air defense and ground stations of antiaircraft have to know that this is a legitimate mission.

A tremendous number of messages are flashed over this network. Radio stations make a cobweb of radio frequencies. The AAF uses latest high speed communications equipment, with rapid handling of as high as 120 words a minute. Operating and installing personnel are the keystone of this network.

Life is grim at AACS stations on the North Atlantic route, where the temperature often is 20° below, where nothing exists but icebergs and black basaltic rock.

At one radio range station "somewhere beyond Hudson Bay" men regularly go out in four feet of snow to keep their tower in operation. Despite the bitter weather, they maintain the power supply for radio beams that AAF pilots depend upon enroute to war theaters.

AAF bomber squadrons operating from British bases follow RAF radio procedure on missions. Let's see how radio helps the *Fortresses* to carry out a typical attack in force against Hitler's Europe—an attack pushed through the overcast when even the bomber's engines give uneasy movements.

In the briefing room, somewhere in the English countryside, the commanding officer tells radio operators the operating frequency to be used, as well as the medium frequency direction-finding section allotted for the mission. "Flimsies"—notes on call sign frequencies and other information on paper thin enough to be de-

(*Continued on page* 304)

FLYING

"SOS—but don't hurry!"

When he fights *Sitting down* he needs a seat that *Stands up!*

No civilian seat or chair ever has to bear such stresses as a military pilot seat. Power dives, rolls and spins multiply the pilot's weight by enormous factors of speed and inertia. Yet, for all the super-strength called for, every possible ounce of weight must be saved.

That is why American Seating Company engineers and craftsmen are justly proud of this pilot seat. We designed it. We built it of fine resin-bonded plywood. The Army Air Forces swiftly adopted it.

Among the famous combat and observation planes for which we produce these pilot seats are: **Douglas "Havoc", Republic "Thunderbolt", Curtiss-Wright "Warhawk"** and the **Stinson "Sentinel."**

And many of the pilots who are flying these planes were trained in **Boeing "Kaydets"** and **Fairchild "Cornells"** built by **Fairchild and Aeronca.** These trainers are also equipped with American Pilot seats.

★ ★ ★

Other American Seating Company victory products include: tank seats, complete airplane wings and control sections, maritime mess tables and chairs, military classroom and chapel seating. Each such assignment receives our best and utmost care, backed by fifty years of quality manufacture.

This American Seating Company new type pilot seat won prompt approval; is currently standard on the warplanes mentioned; conserves critical materials; possesses several unique advantages.

American Seating Company

GRAND RAPIDS, MICHIGAN

WORLD'S LEADER IN PUBLIC SEATING

Manufacturers of Theatre, Auditorium, School, Church, Transportation and Stadium Seating
Branch Offices and Distributors in Principal Cities

DRAFT EVERY IDLE DOLLAR INTO U. S. WAR BONDS!

Flying High

Broaching a three blade propeller hub in the Lapointe 4L variable speed Hydraulic Broaching Machine.

Flying high like a song on the wing goes the smooth effortless flow of power in the air. Like the quill from an angel's wing — like stardust on the moon — like a dream for the future — is the romantic story of broaching today.

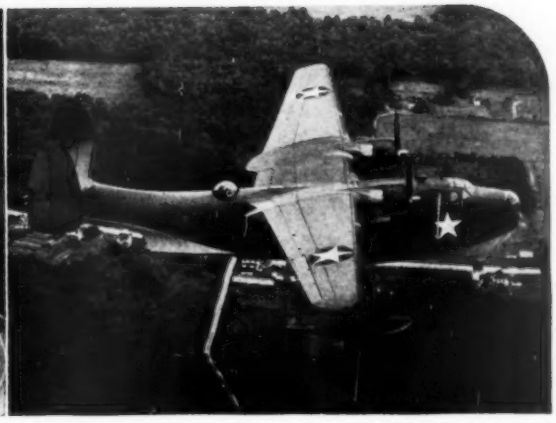
Just as the broach turned the horseless carriage into the family runabout, so also is broaching turning the flying chariots into dependable mass produced precision birds of flight.

ARMY E NAVY

The LAPOINTE Machine Tool Company

HUDSON, MASSACHUSETTS, U. S. A.

Consolidated's B-24 "Liberators"



Martin's PBM "Mariners"

Clarke-Aero

Hydraulic Gun Turret Control Valves

★ Smooth, Positive Control

★ Ease of Adjustment

★ Definite Feel

Adaptable: Fits wide variety of turrets.

The HIGH qualities as found in the Clarke Aero-Hydraulic Gun Turret Control Valve account for the effective firepower obtained in turrets using the Clarke Valve. The design of the valve is such that it affords maximum flexibility as to mounting position, length of column and style of grips.

This flexibility of design makes the valve adaptable to a wide variety of turret installations.

CLARKE AERO-HYDRAULICS, INC.

PASADENA, CALIFORNIA

CLARKE AH AERO-HYDRAULICS

(*Continued from page 300*)

stroyed in an emergency—are distributed.

Prior to the mission, each radio operator has made his daily test of equipment and the preflight check of all radio installations in the bomber.

There are at least five types of radio equipment in the bomber to be inspected: The liaison set—the ground-air link—is used to contact the bomber base, to obtain a fix or position, and to obtain bearings in flight. This long-range set is used sparingly during the mission to receive instructions if the situation changes after take-off.

The bomber's plane-to-plane link is a low-powered command set used by the formation leader to instruct other elements of his flight and to converse with escorting fighters, if any.

A prime navigation aid is the radio compass for direction finding—tuning in enemy as well as friendly D/F or broadcasting stations for radio bearings or for "homing" on the return to base. Aerial navigators also use the liaison set for communications to obtain aircraft bearings from friendly ground stations. Both these navigattion methods use the "A" signal code. QDM 30, for example, means "your magnetic heading to my station is 30°." "QTE" means "your true heading to my station is 30°."

Some American big bombers are equipped with radio altimeters which show the pilot his terrain clearance regardless of changes in barometric pressure—a vital need on flights hundreds or thousands of miles into hostile territory where we lack full information on climate and geography. A bomber's sea rescue radio set is a small light-weight transmitter placed in the life raft if the bomber must be "ditched." This radio transmits automatically on the distress frequency when survivors in the life raft crank the apparatus.

The radio operator has checked all this equipment and more before the pilot taxies out for the take-off. While the bomber rumbles down the runway the radio man switches on all receivers to be sure they are working. He sets the command radio at the "receive" position on the airdrome control tower frequency. The receiver and liaison set are adjusted to the wing operational frequency. No transmission is allowed now.

After take-off, the command set is placed on the emergency frequency to hear a "squeaker" transmitter which sounds if the bomber is nearing a British balloon barrage. The operator keeps an ear on the wing operational frequency but does not transmit.

Once away from Britain, the transmitter of the liaison set is adjusted to the frequency of the medium frequency direction finding (MF D/F) section. This practice saves time if the bomber has to be "ditched" in an emergency and must notify the home base instantly. The receiver is left on operational frequency.

Suppose engine trouble develops over the North Sea. The pilot tells the radio operator to signal that the crew may have to "ditch." The navigator gives the radio man their estimated position, which is sent immediately to the MF D/F station. If the engines right themselves and the emergency passes, the warning message is cancelled.

Now the bomber is nearing its target, a German seaport. The navigator asks radio for bearings on three German beacons to obtain a fix. This the operator does by using the loop antenna. The operator meanwhile learns from Bomber Command Headquarters that the beacon should not be used, informs the navigator, gets his bearings from German broadcasting stations instead.

Over the target itself radio performs best in silence. The navigator and radio man let the bombardiers take over on the return trip. Radio, however, helps the bomber obtain a fix near the English coast, guides the crew to their base and warns of enemy aircraft or unexpected weather changes.

There's also a special radio which permits the bomber crew to identify itself as friendly on returning to the English coast. If this were not the case British aircraft would make it hot for any returning AAF or RAF bombers.

Here in America, the AAF Pilots' Advisory Service has inaugurated flight control for all point-to-point flights of military aircraft in the United States in two areas of especially heavy air traffic.

Areas are the Northeast—New England States and part of New York—and Northwest—Washington, Oregon, Western Idaho and northern California. This safeguard will be in force throughout country by the end of 1943. It makes possible close contact with pilots on cross-country flights, gives latest, most trustworthy information, and should further reduce the number of accidents and speed air rescue. Specially trained AAF officers are located in existing CAA traffic control centers. These experts supplement the valuable work of CAA personnel by extending an advisory service to AAF pilots flying off regular airways. END

Nerve Center

(*Continued from page 125*)

place the Army has established a special civilian personnel section responsible for all civilian employment from nationwide civil service sources.

Jobs are open to civilians only when men or women with specific talents are requested by respective section chiefs. Civilian Personnel hires and fires, promotes and demotes, sees to workers' morale, keeps them fed, looks after their financial worries with debit-credit aid.

These are soldiers without uniform. Some are crack engineers who have turned down fortunes in private industry to help war's work. Here they have unlimited resources to create valuable ideas for victory. Many have sons in the armed forces and regard their job at Wright Field as a citizen's trust.

Civilians at Wright are doing a good job. Many go up daily on test flights. Sixteen men volunteered to test new electrical devices in big planes flying above 30,000 feet. Daily for nearly three weeks, until military personnel could be obtained, they went aloft in *Flying Fortresses* for eight hours at high altitudes, sometimes suffering severely from lack of oxygen.

Others have taken experimental winter flying clothing up to the Arctic regions and lived for months in the severe cold to test the equipment. Several employees acted as "guinea pigs," lived for several weeks on Army field rations for paratroopers. Others have tested helmets, gloves and boots for long hours inside cold chambers where the temperatures drop to —70°.

Another group entered the "stratosphere" in a special pressure chamber on the ground where aero medical research experts could study their reactions. Results will help our high altitude bombers reach Axis targets.

Wright Field's veterans have taken untried parachutes and unhesitatingly dived over the side of aircraft to see how the parachutes would work. Some have been killed when experimental aircraft have crashed during trial flights. Others have rescued Army officers and fellow civilians from plane crashes right on the field.

The field is also the home of the Technical Data Section where men who keep the records labor industriously to maintain a file system of the million different projects which go on at Wright Field.

In the Equipment Laboratory (Parachute Branch), engineers have a new type parachute they are test dropping. They want to determine the exact instant that parachute opens in the air, how fast it descends in inches per second, how far it drifts, how hard it lands. To know the exact answers, they make a slow motion movie of the whole procedure.

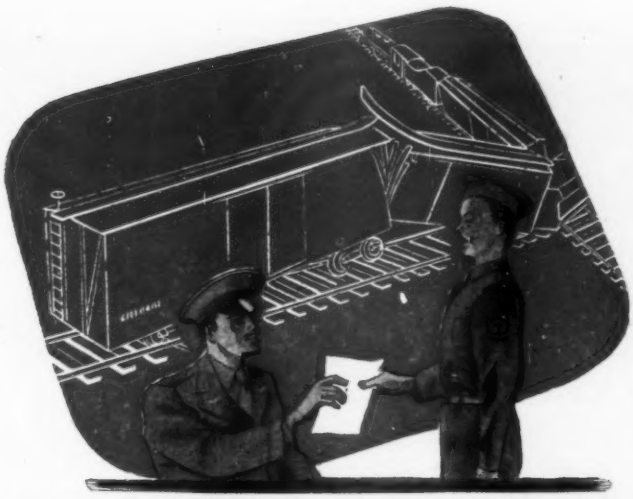
Engineers studying the dangers of fire in aircraft once pushed an obsolete airplane fuselage against a solid wall. This caused a time fuse cap in the plane to explode, setting fire to the ship.

As closely as the human eye could watch, they clocked with stop watches the exact second that the flame burst out. But they were wrong.

A color motion picture camera trained on the whole test showed a little spark which the human eye didn't see. This spark had started seconds before the recorded time of three engineers. The quick eye of the camera had saved the test—and saved many a life in combat.

Another records section—the Materiel Center Administrative Office—handles all military personnel matters. Here the files will tell you who the men are in the Army that are doing the big and little jobs at Wright Field. File papers, for instance, can spot the career of General Blank, who came to the field in 1929, went to Hawaii, the Philippines, came back to Wright in 1940, is now "somewhere in Africa." They know exactly where he is, what he is doing and why.

Soldiers are everywhere. On "top of the hill" is located the Headquarters Squadron and that means supply, training, mess facilities. It means hundreds of new records. It means, more than ever before, that Wright Field is a military post and that this big, experimental research center has gone to war. END



"Re-route damaged stabilizers to Aero Services for repair"

A grinding crash...a speeding freight train wrecked! In those splintered cars below, heavy bomber stabilizers jammed together. A dismal looking mass. No time to waste. Out West the Air Forces need those spare parts. "RE-ROUTE DAMAGED STABILIZERS TO AERO SERVICES FOR REPAIR!" comes the order from the Army Air Force Command. Not back to the factory to disrupt the already overcrowded production lines. We receive those stabilizers, repair them good as new, rush them on to the Air Forces Depot.

That's our specialty...rebuilding damaged aircraft parts and surfaces. A specialty more highly developed here than elsewhere in this country. The tough jobs. Those the aircraft maintenance depots aren't equipped to handle. Everything from ground-looped trainer wings to flak-torn surfaces and damaged floats. From the Solomons and the Aleutians. Into them we breathe new life, send them back to war once more against our enemies. *Every damaged aircraft returned to battle equals a new one fresh from the assembly line. Time saved. Money saved. Tons of critical material saved!*

Our facilities are extensive and complete. We even make the parts necessary for repairs if they are not obtainable from the manufacturer. Precision work is assured by converted production jigs and fixtures and a personnel with the skill developed only by years of broad experience.

Perfection is our motto. It's expected of us. Economical operation, too. That's why salvage pays, why shipments to and from our plant increase each passing day. Army and Navy Air Forces count on Aero Services to return more aircraft to service.

Aero Services INC.

J GORDON HUSSEY, PRESIDENT

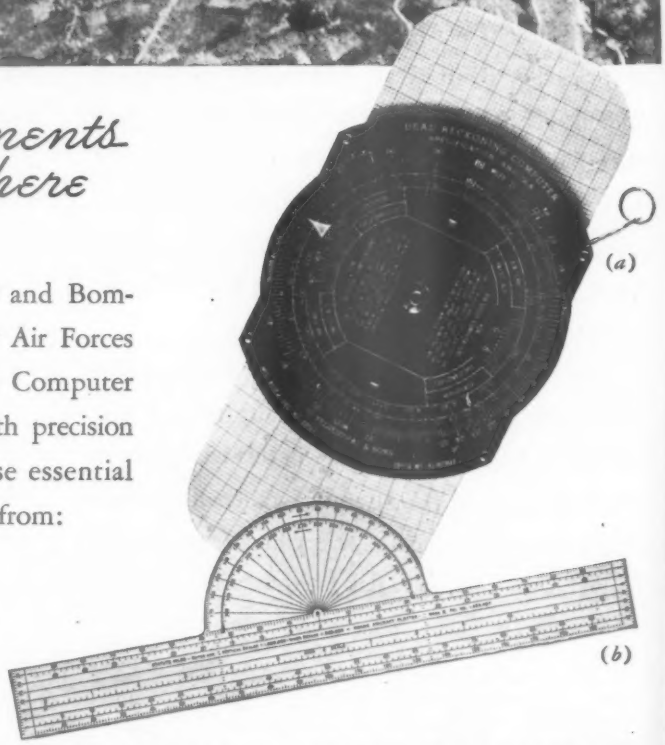
• RECONSTRUCTORS OF DAMAGED AIRCRAFT
CONTRACTORS TO ARMY, NAVY AIR FORCES
METROPOLITAN AIRPORT • VAN NUYS • CALIF.

U. S. ARMY 8TH AIR FORCE FLYING FORTRESSES RAIDING GERMAN SUBMARINE BASE AT LORIENT, FRANCE, MARCH 6, 1943

The Two Instruments that get them there and back

Official equipment for Navigators and Bombardiers in the United States Army Air Forces are the well-known Dalton E6B Computer and the Weems Aircraft Plotter, both precision made in Felsenthal Plastics. These essential instruments may now be obtained from:

Weems System of Navigation, Annapolis, Md.
Abercrombie & Fitch
45th and Madison, New York City, N. Y.
Von Lengerke & Antoine
9 North Wabash Ave., Chicago, Ill.
Air Associates, Love Field, Dallas, Texas
Pan-American Navigation Service
12021 Ventura Blvd., North Hollywood, California
The Powers Company, 106 St. Michael St., Mobile, Ala.



(a) DALTON E6B Computer (AN5835—Spec. AN-C-74)—$10.00
(b) WEEMS Aircraft Plotter, Mark II—$2.50

Precision made in FELSENTHAL PLASTICS

G. FELSENTHAL & SONS, 4100 WEST GRAND AVENUE, CHICAGO 51, U. S. A.

A JAP BULLET HOLE COULDN'T KNOCK THIS VALVE OUT OF SERVICE

THIS Thompson sodium-cooled aircraft valve was pierced by a 25-caliber Jap machine gun bullet during a battle of British and Jap pilots on a far Eastern front.

The sodium, which is the coolant for the valve, drained from valve head and stem, through the bullet hole, and was blown through the engine exhaust.

The tough metal held intact; had the valve head broken off, it would have wrecked the engine, and perhaps cost a lost plane or the life of a brave young pilot.

But the Thompson valve, without the sodium coolant and with weakened stem, carried on for 110 more flying hours (approximately 30,000 air miles) before its condition was discovered during a routine engine overhaul.

"*Ordinarily,*" commented an official of the Wright Aeronautical Corp., "*a valve with the sodium shot out of it should burn and cause trouble. Or the jagged edges around the bullet's exit point should have spread into wide cracks and caused the valve to break. The fact that the valve kept on working indicates the quality of material used and shows how much punishment the American-built, air-cooled radial engine can stand.*"

Nineteen thousand Thompson workers take pride in this story of a battle-scarred valve—it is graphic proof that their energy and craftsmanship are helping our country and our allies win battles.

Curtiss "Mohawk"

It was in this type of fighter plane that a Thompson valve took a Jap bullet through the neck. Nine sodium-filled exhaust valves, and other Thompson parts go into the 1200 h.p. Wright Cyclone engine which powers this American-built pursuit ship. Many "Mohawks" are used by Britain's Royal Air Force in the Orient.

Thompson Products, Inc.

THOMPSON AIRCRAFT PRODUCTS CO.

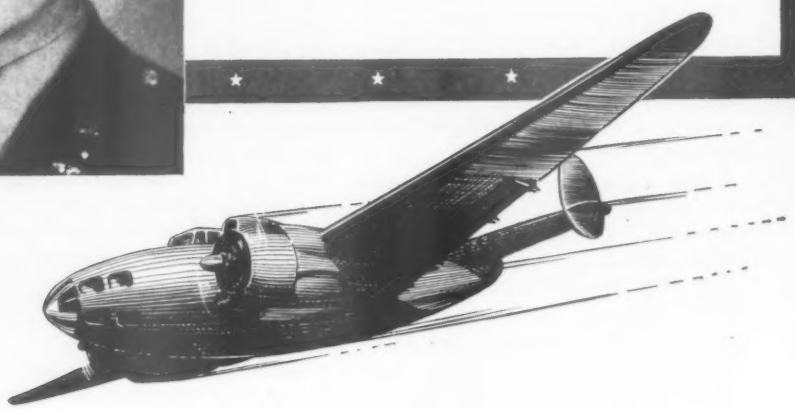
Manufacturers of Automotive and Aircraft Parts

General Offices: Cleveland. Plants in Ohio, Michigan, California, and Ontario, Canada

Beating Production Schedules on Vital Parts for Planes, Tanks, Submarines, PT Boats, Torpedoes, Jeeps, Half-Tracks, Tractors, and Trucks

"Important as the AOPA was to private flying in peacetime, I believe it is even more important now as the sole agency to protect conscientiously the future of private flying."

LARRY CLINTON
AOPA Member No. 2655



THIS voluntary commendation from Larry Clinton is typical of the many spontaneous tributes from registered AOPA pilots throughout the country saluting AOPA for its dauntless pre-war leadership and the vital work it is now doing for non-scheduled flying. If you have soloed, you can become a member of AOPA—the one pilot's organization that is now building a sound foundation for private flying's glorious future. Write or send convenient coupon for free descriptive bulletin.

AIRCRAFT OWNERS AND PILOTS ASSOCIATION
Washington Service Office, Dept. F1043
1003 K Street, NW
Washington, 1, D.C.

Please send me full particulars on how I can participate in AOPA's important wartime activities and help build a sound foundation for private flying's glorious future.

NAME.....
(Please Print)

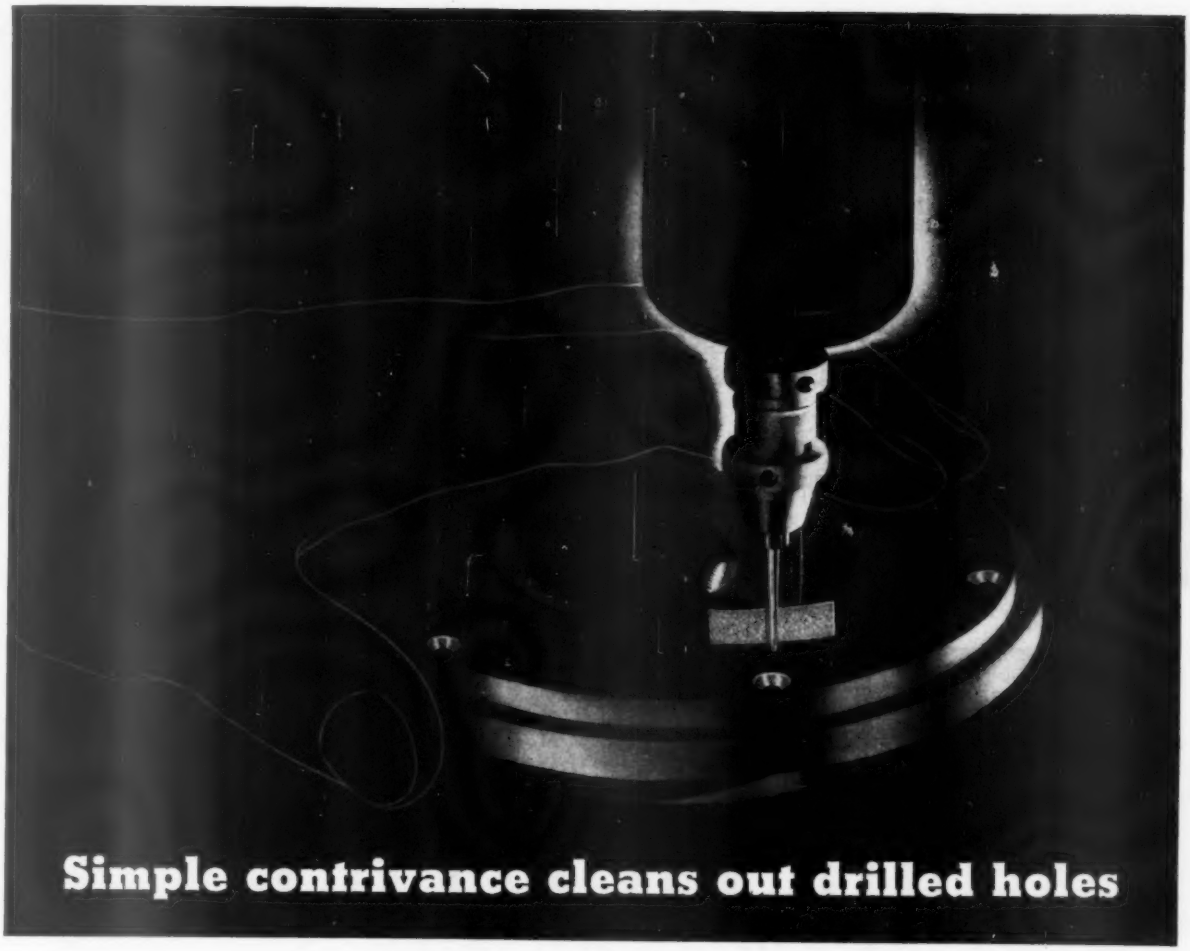
ADDRESS.....

CITY & STATE.....

PILOT LICENSE NUMBER.....
(Sent only to aircraft owners or non-scheduled pilots who have soloed.)

AIRCRAFT OWNERS AND PILOTS ASSOCIATION

REGISTRAR'S OFFICE:
MICHIGAN SQUARE BUILDING CHICAGO 11, ILLINOIS ★ WASHINGTON SERVICE OFFICE:
1003 K STREET, NW WASHINGTON 1, D. C.



Simple contrivance cleans out drilled holes

Information supplied by an Industrial Publication

Complete removal of metal dust or burrs from drilled holes is often difficult. Under some circumstances the particles become electrically charged to an extent that makes them stick tightly to the sides of the hole. Ordinary shaking or blowing is not enough to dislodge them.

A system for cleaning holes has been developed in an Eastern manufacturing plant that should be of general interest because of its simplicity, speed and effectiveness.

It is known at the point of origin as crossing a darning needle with a butterfly. A strip of fine abrasive cloth is threaded through the eye of a common darning needle. The assembly is put in the chuck of a portable electric drill.

The action of the abrasive cloth, revolving at high speed, effectively removes any metal particles clinging to the drilled surface. It also gives the surface a light polish, but there is not enough pressure developed to cause any scratches or marks.

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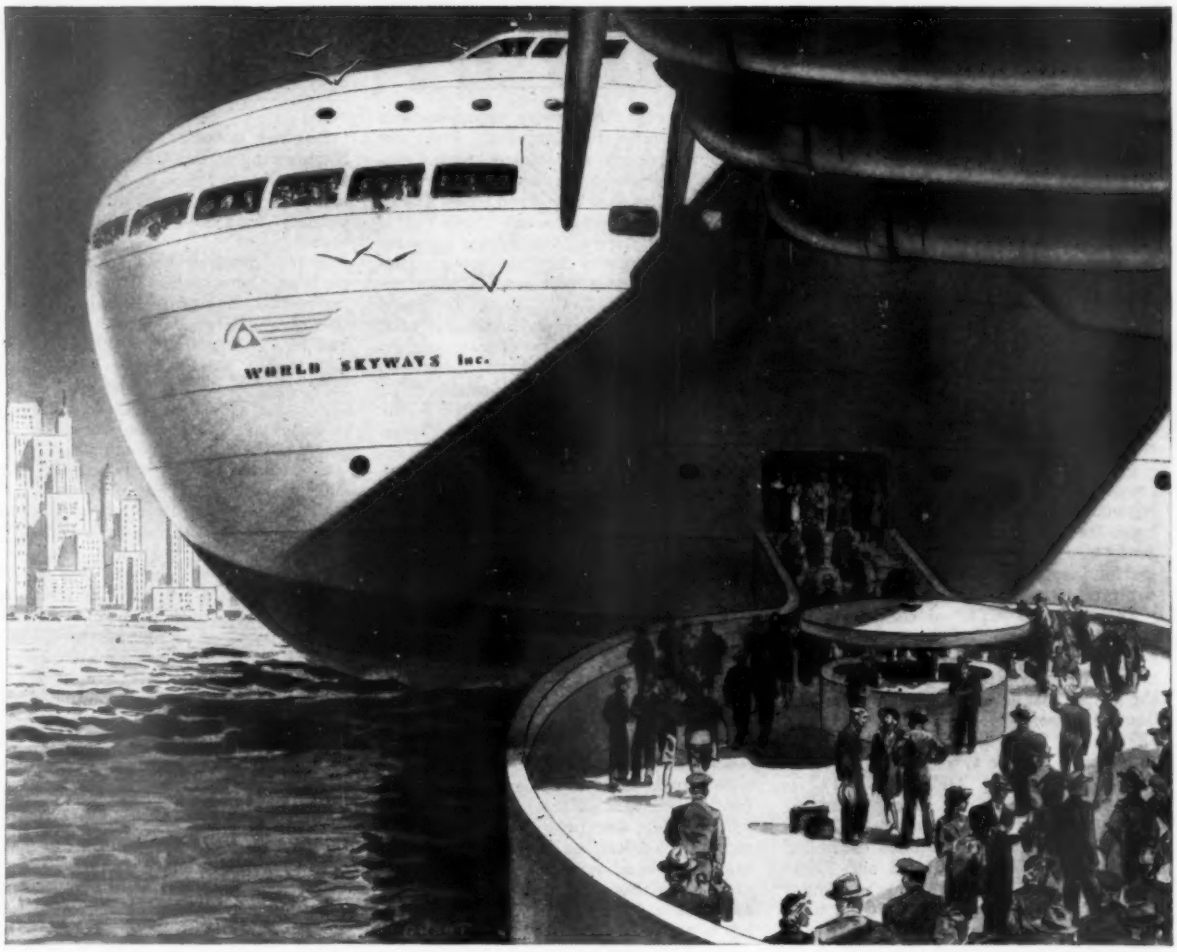


BETTER GEARS FOR TOMORROW'S SKYLINERS

A new era in transportation is on the way! Already skyliners of the future are past the experimental stage, and tomorrow promises a world of short distances—a world where Bagdad and Cairo, Moscow and Budapest will be little more than sleeper jumps from New York.

The giant engines to power these airliners of the future are today a reality. The war's end will find them ready to take over the transportation problems of a world at peace.

Making gears for these engines is Foote Bros.' job. And these gears represent a new advance, both in gear design and gear manufacture. For transmitting the great loads developed by modern aircraft engines demands heretofore unheard-of standards of precision—a precision that must, of necessity, be coupled with extreme lightness. Today these gears are rolling off Foote Bros.' production lines in amazing quantities—gears that mark a revolutionary development in the transmission of power.

When the war is won and these new gears can be produced for peacetime industry, they give promise of new efficiency—new economy to American manufacturers, whether they be applied to skyliner engines or machine tools, farm machinery or motor cars.

FOOTE BROS. GEAR AND MACHINE CORPORATION
5225 South Western Boulevard • Chicago, Illinois

ARMY E NAVY

FOOTE BROS.

Better Power Transmission Through Better Gears

Planes by the Thousands

(*Continued from page 133*)

was growing up. In 1942, it became the Production Division of the Materiel Center. Its offices housed nearly 2,000 personnel and 200 officers. Many more have been added since. Now it reaches out into all the plants that are making aircraft or aircraft parts.

Here are written the rules that govern the manufacturer who is producing America's big new Air Force. Here are the eyes and the ears of the Army Air Forces keeping alert for groans and squeaks in our production machinery.

Today the Production Division is divided into three sections: Production Engineering, Production Control and Industrial Planning.

Part of Wright Field lingo is the expression "GFE"—Government furnished equipment. This involves all adopted types of equipment furnished by the Army Air Forces to aircraft manufacturers for installation in their airplanes under production.

There is also "CFE" or contractor furnished equipment — instrument panels, gun mounts, seats, controls which are furnished by a contractor and installed in the aircraft while they roll along the production assembly line at the factory. Generally "CFE" pertains to items destined for a specific type of plane.

The necessity for "GFE" and "CFE" is obvious. Consider, for example, an air speed indicator or a tachometer. The industry would be in continuous turmoil if Boeing, Consolidated, Martin and Lockheed all tried to buy that particular gadget from the same source at the same time. Orders would conflict with each other and contracts would be held up.

Therefore Air Forces buys a "GFE" item usable on more than one type aircraft and distributes it to the plane manufacturer as required. Nearly 4,000 GFE items in use today include propellers, engines, instruments, hundreds of others common to both fighters and bombers.

Production Division also faces such problems as these:

To make certain that some 15,000 manufacturers receive the necessary raw and fabricated materials in the proper amounts at the proper time.

To provide additional facilities in expanding present factories or constructing new ones and to provide additional machines and tools.

To see that manufacturers keep up to a scheduled production.

To distribute parts to aircraft manufacturers.

To assist in engineering the methods of production.

To make changes in construction features without slowing up production lines.

Most important, to see that a steady flow of battle planes is on its way to the various fronts in ever-increasing numbers.

Production programs are prepared by the Chief of Staff, AAF, who submits them to the Materiel Command for estimates of cost. Necessary appropriations must be voted by Congress. Programs are forwarded to the Joint Aircraft Committee, which co-ordinates with the scheduling unit of the War Production Board for materiel requirements.

The Joint Aircraft Committee prepares separate programs for the three structural units of an airplane—air frames, engines and propellers. These programs outline the scheduled production for each item based on availability of materials, establishment and approval of additional facilities, if required, and priorities.

Directives are forwarded through the Commanding General, Army Air Forces, to the Materiel Command. Technical instructions dictate the quantity of each airplane by type, requirements and delivery. These instructions are disseminated to the interested branches and sections by the administrative staff of Production Division.

Each of the three sections of Production Division has its job to do.

Production Engineering personnel must draft complete specifications for each item to be produced. They must initiate the original Authority for Purchase which starts procurement, and buy all of the "GFE" through Production Division's Aeronautical Equipment Branch.

Assigned to Production Engineering Section are air officers expert in their field. They are project engineers and serve as chiefs of the four aircraft branches—bombardment, pursuit, observation, training and transport. Recently added is a fifth project engineer whose job is gliders.

The four airplane branches are responsible for the engineering administration of all contracts for the purchase and manufacture of production aircraft, preparation and release of military characteristics for production aircraft, approval of type and model specifications, and the issuance of authorities for purchase, specifying quantities, design and performance, delivery requirements and initial spare parts based on approved programs.

When negotiations for the procurement of aircraft are conducted, co-ordination with the Air Force Section is maintained in order to establish the list of spares required and deliveries of certain proportions concurrently with the deliveries of the airplanes. The airplane branches also are charged with the preparation of all engineering orders and requests for change orders on airplanes and spare parts.

The airplane branches also prepare check lists, preliminary operation instructions, flight test loading schedules, approve and release drawings and revisions thereto, and prepare and distribute data covering special features peculiar to new models of airplanes initially released to service units.

The Aeronautical Equipment Branch performs approximately the same functions in regard to GFE as do the airplane branches on the planes. This branch is composed of units dealing with certain specific items such as landing gears, propellers, armament, power plant, electrical instruments, radio, miscellaneous items, photographic and organizational equipment.

Another important unit of Production Engineering is the Conservation Branch. Essentially its job is to save all vital war materials possible and to substitute nonpriority materials for those that are scarce.

A few months ago engineers and experts of Conservation Branch sought to reduce the amount of aluminum used in one of our large bombers. The bomber had many little interior fittings made of aluminum. These were replaced by light, strong plywood parts that did the job just as efficiently, and, in some cases, even better. Today the process is being applied to most of our bombers.

Conserving materials is one thing, getting them at all is quite another. This task belongs to Production Resources Branch of the Industrial Planning Section, Production Division.

Working in conjunction with the Aircraft Scheduling Unit of War Production Board, Production Division determines what is required by manufacturers in the way of raw or fabricated materials, plant facilities, machinery and tools.

Wright Field men have found needed aircraft metals being diverted into other plants although they were vitally necessary to step up our bomber production. Resources Board men went after these materials and upped our plane production. Often they have found plants with insufficient room to turn out a vitally needed airplane instrument and have helped locate bigger facilities.

Originally the Special Projects Branch of the Production Division was established to administer changes common to all aircraft.

The duties of this branch have enlarged with war. Our observers overseas have brought back important information that has changed our designs. These include leakproof tanks, armor plate, increased firepower. Other necessary improvements in our aircraft are being made right along.

Modification centers have been established by aircraft companies under AAF supervision to install GFE and CFE equipment which was not earlier available. These centers also revamp equipment for our Allies' use.

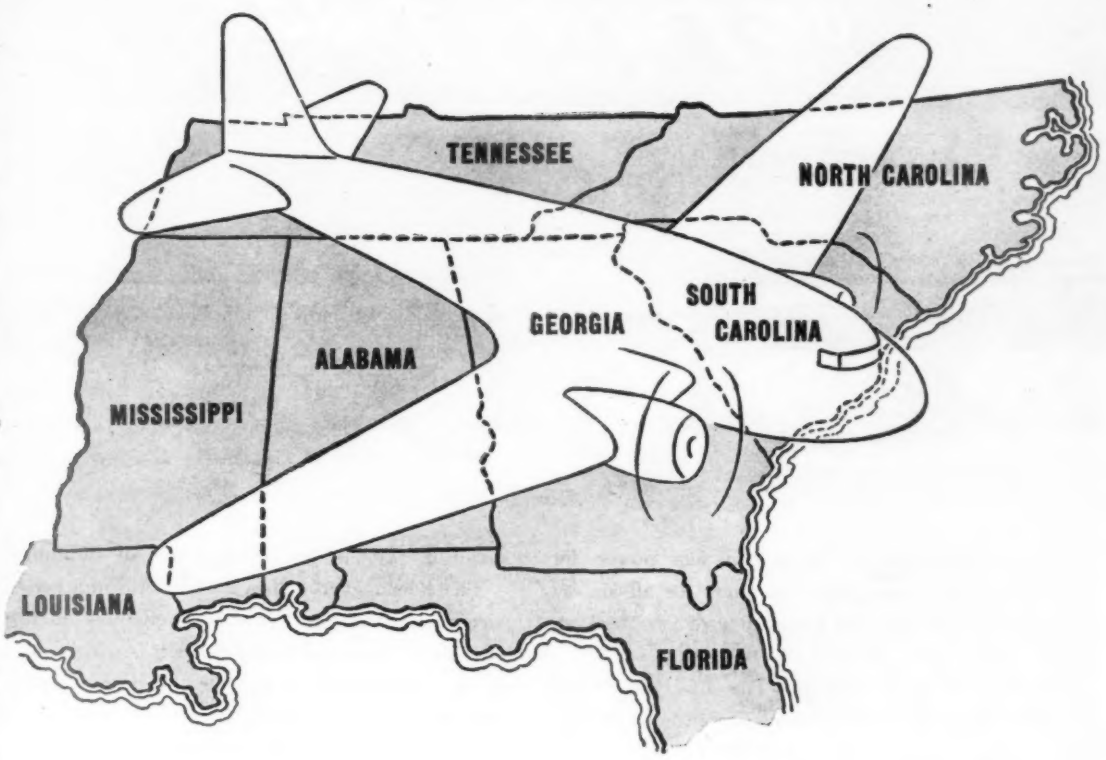
Work performed at these modification centers has increased vastly. Actual combat experience of one U. S. bomber disclosed insufficient forward fire power. The enemy discovered this too, with unhappy results for several crews. A directive was promptly issued to install additional guns in the nose of the plane and the work was performed at a modification center.

Often it is necessary to recall airplanes on which major modifications are necessary but which cannot be performed because of pressure of other work at Army Air Forces depots and stations.

Planes destined for the Arctic are sent to a modification center to be winterized.

(*Continued on page 316*)

THINGS TO COME



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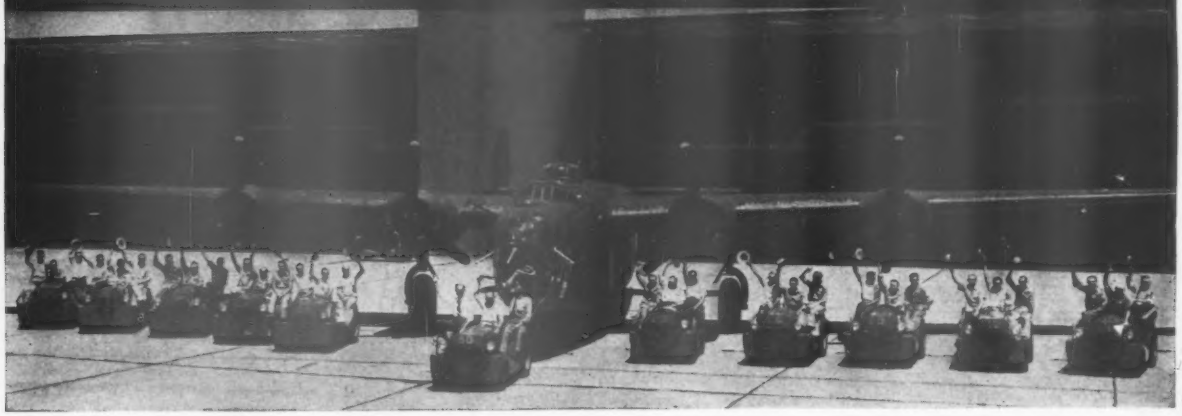

The Ford-Ferguson Moto-Tug has power for heavy jobs—with plenty to spare for all airport work. Its weight and low center of gravity keep it snug to the ground.

Only 46″ high, the Moto-Tug slips easily under most wings and tail assemblies. Automotive type steering, compactness and its 9′8″ turning radius enable it to wiggle in and out of tight corners, make it easy to get in and out of buildings.

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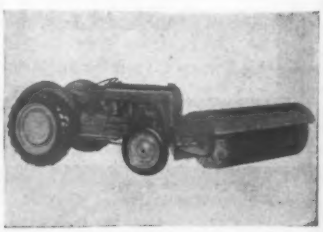

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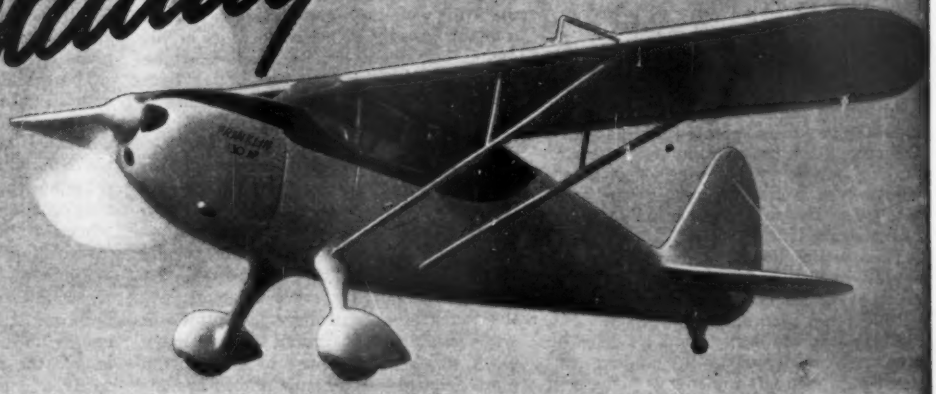


(*Continued from page* 312)

Planes being sent to hot desert regions get special filters to keep out dust from vital mechanical parts.

Standardization of equipment is necessary to get real mass production. Our United Nations agreement has made this job difficult because of the great many customers and the manufacturers' difficulty in coping with the special needs of each buyer. Therefore, each nation's representatives thrash out the problem with Production Division, standardize when possible and compromise when not.

System is maintained by a special section called Production Control. Its personnel are the "trouble shooters" for the Air Forces. They have to determine each manufacturer's requirements for specified GFE and then they have to procure this GFE and distribute it to the plants so that they can meet their projected schedules.

Control must keep tab on all production articles. Machine records show what parts are needed, what parts have been ordered, what each manufacturer is producing and when he will be able to deliver. Production control makes sure that proper items have been ordered by the Production Engineering Section and then follows up the contracts to see that the goods are on hand.

Manufacturing Methods Branch acts as technical adviser to plants, suggests changes and improvements and recommends proper tools and machinery. Its immediate contact with all manufacturers throughout the country makes it possible to pool ideas for all-out production.

These are some reasons Production Division is working overtime at Wright Field. They are giving Goering and Milch and Vandelend (Udet is dead) something to talk and think about in that Berlin hotel room—if the hotel is still there. END

Aerial Gunnery

(*Continued from page* 166)

before are becoming expert aerial gunners in a period of six weeks.

Long courses in the class room familiarize the prospective crew member with the construction, assembly, care and maintenance of his guns.

Then comes his first target work. He begins as a rule with a .22 caliber repeating rifle, aimed at moving planes. He will try his hand with a BB machine gun and then with a shotgun on a skeet range. Then, still on the ground, he will practice first with .30 caliber machine guns and then with the .50's he will use in combat. These guns for practice are often mounted in power-operated turrets which the students must manipulate to fire at moving targets, towed by a jeep or otherwise moved around the range. The practice guns themselves are often mounted in a moving truck.

Then comes the great day when he is actually sent aloft in a plane and has his crack at the sleeve targets, towed 600 feet behind other planes.

But no towed target and no friendly airplanes can repeat for the student gunner the maneuvers an enemy plane will put on in actual combat. Here enters the moving picture. Actual movies have been made on every front, showing every kind of enemy airplane coming in for attack. These are projected in a studio, complete with a sound track that reproduces all the clamor and noise of planes in flight and in battle. On the picture screen there is always evident those parts of the gunner's own plane which he must clear with his bullet stream. And his hits and misses are electrically recorded as he fires at the dodging image on the screen.

Down over Hong Kong the other day a half dozen of our Curtiss *Warhawks* from China had just completed a strafing mission in the course of which they had shot out of the sky 12 to 20 Jap Zeros that had attacked them. As he came out of his last whirl with the enemy formation one of our pilots saw a plane silhouetted against the setting sun and coming straight for him. Instinctively he swung into the attack himself. His finger curled on the trigger button. Just as he was about to press it and send his six .50's blasting at the strange plane, that plane wiggled its wings and a sharp voice came over the radio—

"If that's a *Kittyhawk* ahead, shake those wings."

In that split second the first pilot did and both men held their fire.

Recognition of enemy planes is, of course, one of the toughest problems of training. All sorts of methods were tried. But it was at last found that only the flash method of instinctive recognition was useful in combat. So, in their spare time, student gunners practice recognizing pictures, silhouettes and models of enemy planes which they can see for only 1/100th of a second. A sort of camera-like image is established in the pilot's mind so that he recognizes enemy planes without taking time to stop and figure whether its wing tips are square or tapered.

Estimating range was another difficult problem. It was solved by the adoption of a ring sight of standard size so that, a plane once having been recognized, the pilot, again almost instinctively, knows its distance from the amount of space it takes up in the ring sight or the time it takes to cross from one side of the sight to the other.

Even with the tracer bullets which mark the course of the stream of shot, the pilot must be on the target almost at once —or the target is gone. Various devices have been attempted that would automatically give a gunner the right lead on a plane in any relative position to his own. But again it was found that the human feel or instinct was better than any mechanical device. That instinct is developed through the use of camera guns.

More and more it has been learned in actual combat that human arms are just not strong enough and fast enough to swing a pair of .50 caliber machine guns weighing over 120 pounds. The power-driven turret, therefore, has become the universal mount for these weapons. At the touch of a control by the gunner it will swivel or pivot around the imaginary clock which gunners use to indicate the place from which enemy planes are attacking. "Twelve o'clock" is dead ahead; "three o'clock" straight out to the right; "six o'clock" astern and "nine o'clock" broad off the port beam.

Hence the turret is being more and more used in gunnery training. Even the shotguns used in skeet are now mounted in power turrets so that the student can track a clay bird with the same motion he will use later to track an enemy plane.

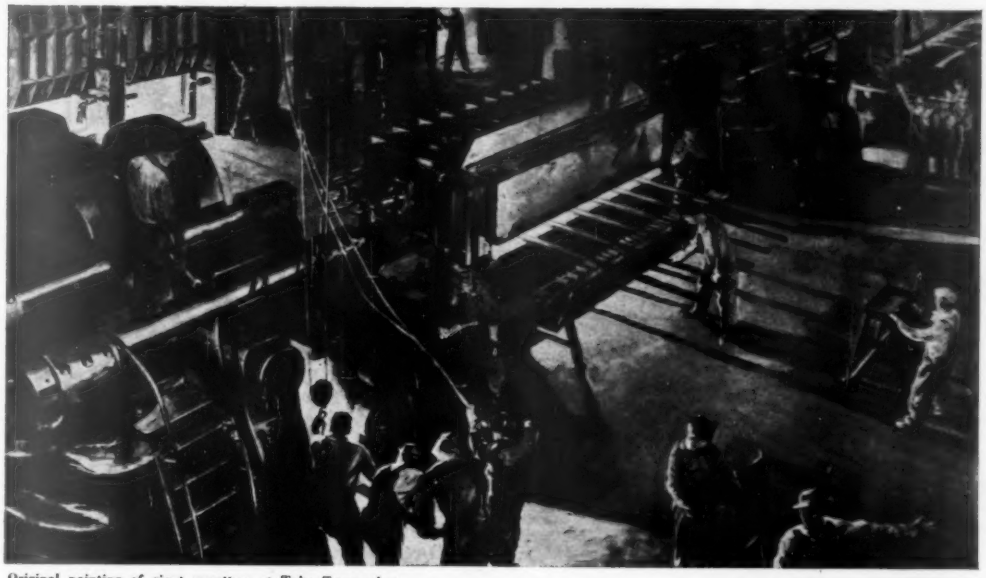
It used to be that the tail gunner was thought to have a sort of suicide job. Enemy planes came down on the tail and he was their first target. With the introduction of the .50 caliber machine gun, however, the tail gunner became anything but a burnt sacrifice. Tail gunners have shot down as many Zeros and *Messerschmitts* as the men in any other position in the bomber, and perhaps more. A tail gunner was the sole survivor of a Boeing *Flying Fortress* shot down over the Solomon Islands.

On the morning of December 1, 1942, the *Fortress* encountered six Zeros on a reconnaissance mission over the Solomons. Sergt. Joseph E. Hartman, tail gunner, got two of them and the other four broke off the fight. A little later six more Zeros appeared, but kept out of the range of the Hartman guns. Not the seventh, however. It was flying high above the others. It tried, without success, to get the *Fortress* with bomb and then, suddenly, apparently out of control, it dived straight for the *Fortress*.

Evasive action was impossible and the Zero plunged head on into the fuselage, just behind the radio compartment, cutting the *Fortress* clean in two. The 10 men in the forward part were carried quickly down to death. Hartman, despite the fact that the tail was ablaze, succeeded in getting out and opening his parachute. He spent 67 days with friendly natives who hid him from nearby Japs and finally paddled him 225 miles in 12 days, with 21 men in the dugout, to a point where a naval vessel picked him up and returned him to his base. He was awarded the Silver Star.

Another gunner, Sergt. H. T. Ade, was thrown out of the top turret of a Douglas *Havoc* over Africa and lived to tell the tale. The ship, returning from a bombing mission, was attacked by Focke-Wulfs. Ade had just got off his first burst at one plane when the *Havoc's* pilot was killed. The plane went into a violent spin and Ade was wrenched from the top turret, past the lower gunner and out the bomb bay door. He was the only man able to get his parachute open before the plane crashed.

These and many more veterans of the actual battle are now back in the United States, teaching the gunnery students what they know. Aside from actual battle experience, they are rapidly imbuing these new boys with the spirit of the gunners' corps. Like pilots, they, too, wear wings. Pilots recognize them as essential members of the combat team which mans a bomber. They, with their .50's, pack those left jabs and hooks that enable the bombardier to land that final kayo on the enemy targets and they are the boys who enable the pilot to fly back home again to fly and fight another day. END



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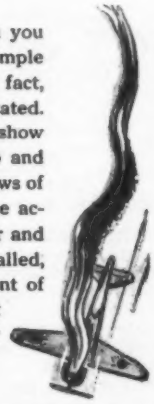

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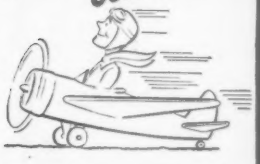
ACCURATE CONTROLS



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In these frequent messages, Roebling salutes each member of the aircraft industry in turn.

ROEBLING

means Control in the air

Field Maintenance

(*Continued from page* 193)

movable surfaces, flight control mechanism, first-aid kits, cockpits, cabins and safety belt.

The crew make minor adjustments immediately. More serious difficulties may require the services of a sub-depot or mobile service unit, equipped with special tools and facilities. Overhaul of engine or airplane structure requires a trip to the nearest air depot, where whole aircraft can be rebuilt if necessary.

During and after the 25-hour inspection, "Yank" goes right on with the war. Daily inspections and minor touch-ups are all in the day's work for the mechs.

One morning "Yank's" pilot discovers his fighter will be grounded for a few days. Patterson Field has ordered all planes of the type to be flown to Air Depot X for a major operation involving vital new parts. "Yank" and family are grouped as a "project" in Depot X or divided among several depots if facilities or the war situation demand it. Depot engineers also seek and repair hidden battle wounds or other ailments.

Such jaunts to the depot are major—and always for good cause.

Perhaps unsatisfactory reports on planes of "Yank's" breed have reached ASC headquarters from the fronts. The manufacturer may have discovered a new device that will increase flying safety or combat efficiency. Or AAF experimental engineers may have developed improved carburetion which ASC decides must be installed in service aircraft at once. If "Yank" is about to be shifted northward, it must be winterized. A desert assignment demands other equipment, such as filters for sand storms.

A technical order outlining the whys and wherefores of any major change must be prepared and printed. Necessary parts are contracted for, manufactured, and assembled into kits. Each kit contains every part necessary to make the change. The technical order and the kits are shipped to the depot in advance of "Yank." In an emergency, necessary priorities for air transport must be cleared. Occasionally a technical order is radioed with instructions to use available parts from regular stock and manufacture the rest locally—a big assignment in many AAF theaters. Other technical orders are written, printed and dispatched by air mail from Patterson four hours after a decision is reached. Less urgent orders are distributed by normal channels.

The preparation and distribution of technical orders and other AAF publications is a major function of Air Service Command. In this airman's library are individual handbooks on operation, maintenance and repair to accompany each airplane and engine; inspection guides and forms used by the ground crew; radio facilities charts; illustrated parts catalogs, and publications on any subject from props to insecticides.

Depots are combination flying fields,

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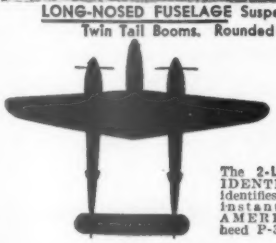
The two planes below look very much alike, although one's a Nazi and the other American. But any youngster can instantly tell them apart with the *2-Line* FLASH IDENTIFICATION.

Aeronautics Photo

LONG-NOSED FUSELAGE Suspended on Wings. Twin Tail Booms. Rounded Tail Plane.

Airpix, Toronto

SHORT-NOSED FUSELAGE Suspended on Wings. Twin Tail Booms. Rectangular Tail Plane.



The 2-Line FLASH IDENTIFICATION identifies this plane instantly as the AMERICAN Lockheed P-38 Lightning.

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storage warehouses and repair shops now established all over the world. These maintain huge stocks of spares and spare parts, including engines, wing assemblies, tail assemblies, more than 150,000 other items that outdo a mail-order house. Less complete stocks are carried by sub-depots and combat units.

Procurement and distribution of these spares and spare parts is another ASC job. Patterson officials must forecast—as accurately as veterans can — how many parts will be required at one time in any area, including combat zones. They must put in the order, arrange for warehousing, find shipping space to get parts overseas to their destinations on time, then set up storage and issue in the theaters.

Meanwhile "Yank" is back on duty ready for its 50-hour inspection roughly 25 hours after the first field overhaul. This includes all items checked in the 25-hour inspection, goes into greater detail, again is performed by its own ground crew.

After 100 total flying hours, "Yank" will receive another inspection, the stiffest yet. As long as "Yank" flies for the AAF these inspections, plus daily and pre-flight checks, will be a regular routine of its existence. For it's the duty of Air Service Command to be sure that "Yank" on duty is as good a fighter as rigorous check-ups and maintenance can make it.

Whenever "Yank's" crew find their charge needs more extensive repair than they can give, the personnel and facilities of Air Service Command, mobile or fixed, are ready to take over.

In combat theaters this problem can be staggering.

The difficulties of performing even routine inspections and maintenance in Iceland or New Guinea are enormous. Work often must be done between bomb or shell bursts by mechanics who keep carbines or rifles at elbow's reach. And not even Messerschmitts have wreaked such punishment as have intense cold or heat, sand storms and tropical downpours.

One cargo ship flying supplies into China was forced down in a remote mountain valley inaccessible by land. Repair parts and two mechanics were dropped by parachute. In that rude Shangri-La those mechanics, working in the open, performed their job with the skill of artisans.

Soon after Pearl Harbor, vital repairs had to be made on warplanes in the South Pacific. There were no technical orders to go by, no parts available.

A technical order was written and rushed out on the first mail plane from the states. Copies were printed, parts were manufactured and assembled into kits, and the complete bundles were distributed to the combat squadrons, all by the use of local services. This seems simple enough, but the printing order nearly swamped the combined facilities of all the printing shops in one area and the manufacture of the parts meant taking over all local machine shop facilities.

In Guadalcanal and other combat zones, airplane maintenance was possible only by resorting to cannibalism—taking parts from one wrecked plane to install in another. Often this work was accomplished under intense fire from enemy planes and ships. Many maintenance men were killed and more were wounded.

These are the "smaller" difficulties. The major woes of ASC here seemed almost insurmountable at times.

In Australia, for instance, railroad lines of different gauges slowed transportation at every frontier. A trainload of supplies could move on one gauge only a few hundred miles. Then everything had to be unloaded and transferred to other cars on a railroad of narrower or wider gauge.

There was one 500-mile gap, en route to Port Darwin, where there was no railroad. Everything had to be transferred from freight cars to trucks, then put back in freight cars again.

Communication in most battle zones was primitive. Certain telephone trunk lines in Australia were of the system that permitted only one message at a time over each line. Teletype lines had to be installed and radio communication perked up.

Most of these major problems already have been licked, often by using American equipment. Our cargo transport planes have increased in number and size. Our own communication lines span the world. American trucks roll over the mountains to far places. Highways were built, railroads laid by American sweat. Far from Altoona and Omaha, American freight trains began rolling.

(*Continued on page* 325)

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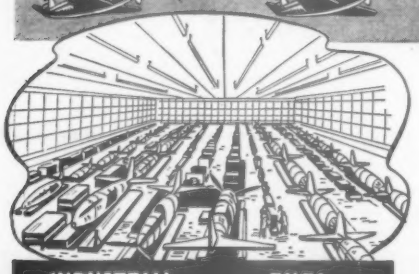

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_turn their binoculars this way!

IN the meager security of a rubber raft, survivors from a lost plane count ahead: How many more days will their food and water last? They count back: How many days have they drifted—*away* from their chances for rescue? Count their chances to live!

Then—so far off, it can barely be identified as one of our own—a single plane.

Saved? Not yet!

Only with binoculars could the men in the plane possibly see them.

Those on the raft, fliers themselves, know that. Know that they have not yet been seen, or the plane would be heading towards them now. Fear that those up there who are using binoculars are too intent on sighting their objective to spot that tiny raft.

If so, their frantic waving is as futile as their shouts, and only prayers can help: "Please, Lord! Turn their binoculars *this* way!"

Every minute of *every* hour of *every* day and night, our men are using binoculars to save lives, uncover ambushes, expose snipers, warn of submarines, sight enemy aircraft.

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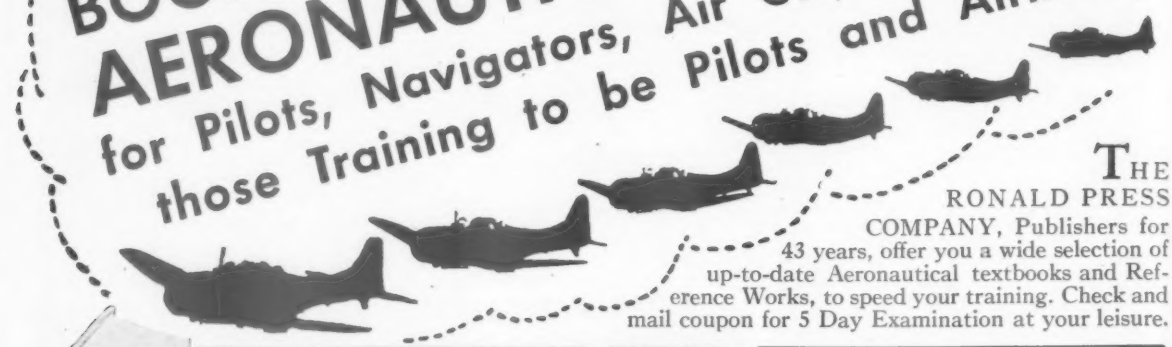

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(*Continued from page* 322)

Now, although many problems remain unsolved, parts and spares, maintenance men and facilities in growing volume are arriving in all theaters.

Within continental United States or in the territories where maintenance facilities are complete, warplanes are knocked down, unbent, spruced up and transformed with the speed of modern industry.

Depots now have production-line techniques for aircraft overhaul and repair. In peacetime it was AAF practice to train and develop airplane and engine mechanics who were able to perform all repair and overhaul operations individually or in crews.

Now acute wartime shortages of personnel have ended this "craftsman" idea. The time required to train full-fledged aircraft mechanics is too long. Today it is possible to train a man or woman to do one production-line job well—and become skilled in the operation within a few days or weeks.

America's standard manufacturing processes allow depot engineers to pool engine parts of the same size and type. These parts are not necessarily replaced in the old engine but are pooled throughout the various processes of overhaul. Complete engines are then re-assembled from parts as they come off the production line. The engines function perfectly —another triumph for American genius at war.

Many other innovations in overhaul and repair procedure have been introduced. But airplane engines, structures and instruments are intricately designed and certain repairs can not be rushed. As war's tempo grows there must be more repairs.

Meanwhile ASC's vigilance is keeping American planes flying in combat zones and service areas under all conditions. It is chore-boy work on a world scale—the kind that "Yank" is winning from Italy to the China Sea. END

Flying Guinea Pigs

WHEN a flyer at Randolph Field's central instructors' school appears over the field with his wheels jammed, the operations office usually asks him to circle the tower of the administration building to be photographed so Army technicians can study the pictures.

Developing the Tools

(*Continued from page* 121)

Conferences may dictate some changes. A scale model for wind tunnel testing is constructed. This model is suspended within a huge metal tube and subjected to high-speed blasts from enormous fans. Ideas become practical in the wind tunnel. Errors are eliminated. Designers may test new fuselage shapes, flying wings, streamlining, pusher propellers, placement of wings, engine nacelles, engine cooling. When a model has completed its wind tunnel tests, its designer is in possession of all performance data on his plane.

Wright Field now has two wind tunnels. One is five feet in diameter. The other is 20 feet, is the world's largest, cost more than $3,000,000, was designed largely by Engineering Division. In its test chamber models with wingspreads of 16 feet may be tested in wind speeds as high as 450 m.p.h., generated by a 40,000 h.p. motor.

The control room, housing scores of delicate measuring instruments, records every model test by ticker tape for future study. The operator at his dials and switches has complete control over the movements of the model or parts "flying" in the wind.

The wind tunnel tests over, the manufacturer builds a full-sized mock-up of the airplane. A "mock-up" is a full scale model with all equipment. AAF officers go to the plant for inspection before work on the first plane is begun.

The mock-up makes it easier to visualize three-dimension features, helps the manufacturer install controls, cables, lines, pipes and wiring without interference. If all inspecting officers are satisfield, the Army tells the company to start building the experimental model.

The Aircraft Laboratory, more than any other unit of Engineering Division, deals with the complete airplane. Its Structures Branch determines aircraft strength by static (weight carrying) and dynamic (impact) tests. Sometimes whole airplanes are broken and destroyed section by section. In static tests, huge lead weights are piled in the fuselage and on the wings to determine maximum military loads. In dynamic testing, an entire airplane may be hoisted by a giant crane and deliberately dropped to give it the same shock that would occur in landing. Tests are mathematically computed, photographically recorded.

A pursuit plane may be designed to take 12 G's (12 times the pull of gravity) when it is pulled out of a dive. That airplane must withstand this terrific load without any piece of metal in the entire structure failing.

One bomber, for example, was originally designed for 41,000 pounds gross load, but as a result of test information these ships today are being flown with 64,500 pounds gross load. When wartime emergency demands the taking of risks to obtain additional range, this kind of loading makes it possible to more than double the flying range.

The static test alone is not enough. An airplane can take all the shot bags and sand weights that are piled on it and still not hold together in the air when a pilot whips it into a quick maneuver. Vibration characteristics may be such that a wing will break away. It has happened more than once. Consequently, a series of flutter tests are made on every airplane by engineers and test experts in the Vibrations and Flutter Unit.

Determining vibration characteristics is comparatively simple. A small reed held up in the wind will begin to oscillate and the oscillation will build up. An airplane wing, an aileron, an elevator or a rudder may react the same way. For this test, a small weight, put on the wing at various points, is vibrated at different speeds until the critical speed at which the weight moves causes the whole structure to vibrate with it.

Another working section in the Aircraft Laboratory is the Landing Gear Unit which attacks the problems of retraction, tire trouble, footprint pressure, overloading of tires, and the design and development of wheels and brakes. All this is expensive. The cost of one wheel on the Douglas B-19 exceeded $40,000. Right now, brakes are undergoing priority research and improvement.

No warplane is effective unless it has firepower—guns and bombs that will de-

(*Continued on page* 331)

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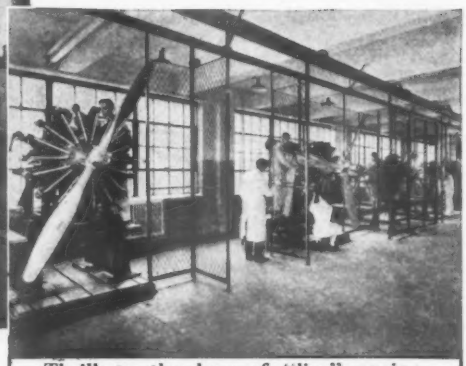

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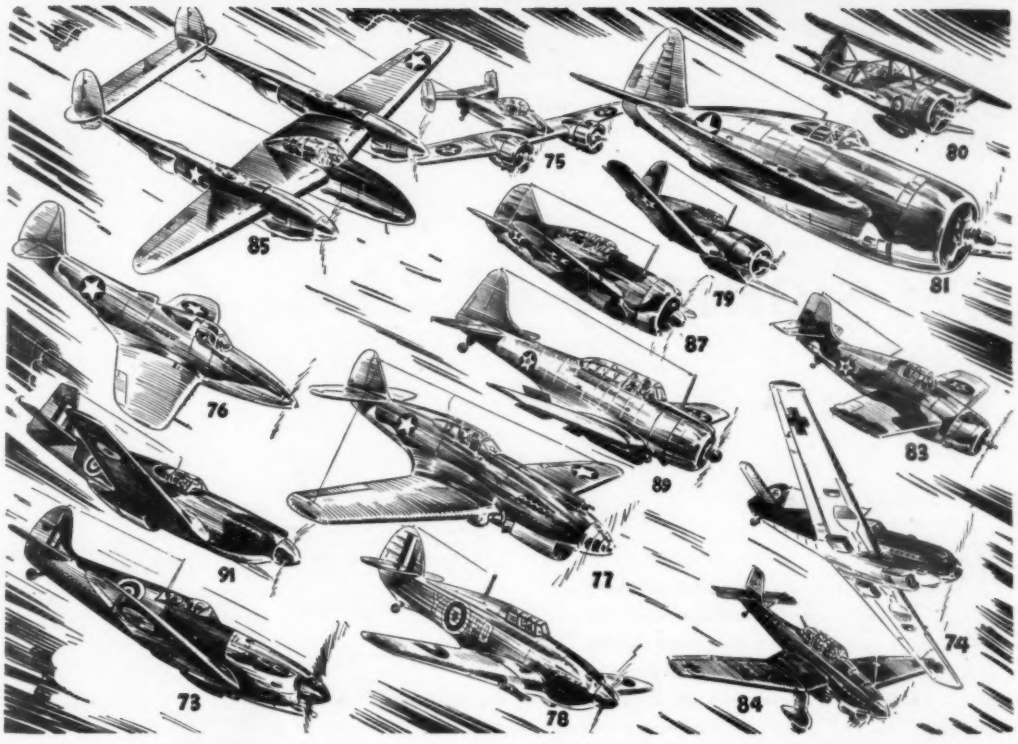

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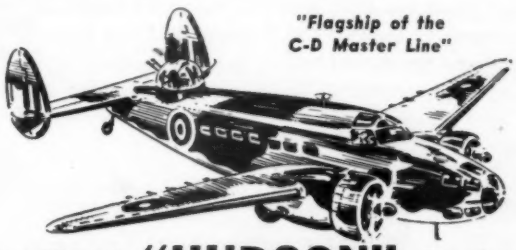

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More of these have been ferried overseas than any other plane. Enjoys wide acceptance by the British Coastal Command operations over the North Sea and Channel areas, and its sturdiness and endurance have gained for it a high reputation with British crews. They call it "Old Boomerang"—for somehow or other it always seems to come back. A powerful bomber, also used for reconnaissance, has done some fighting, too. Has seen plenty of action over Europe, Africa and the wide stretches of the Pacific. Span 49⅜". C-D Master Kit SF-95,

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(*Continued from page 325*)

stroy the enemy in the air and on the ground. That the U. S. has the most accurate bombsights in the world we have been told for years. Now it is proving itself in actual combat. The only thing the AAF bombardier needs is a look at his target. If he can see it in his sights, he can usually hit it, regardless of altitude, speed of the plane, motion of the target or velocity of the wind.

The Armament Laboratory is concerned with the business end of the airplane. Bombsights, bomb releases, bomb racks, bomb installations, machine guns, flexible and fixed guns, fire control mechanisms and gun turrets are its responsibility. We have to know gun mounts, methods of carrying and releasing bombs, operation of gun turrets, the order in which guns will fire, servicing provisions, and methods of feeding ammunition.

Peacetime planning developed aircraft weapons ranging from the small .30-caliber machine gun, capable of firing 1,200 shots per minute and weighing less than 25 pounds, to the 37 mm. cannon that fires slower, weighs many times more. Wright Field research helped produce the heavier .50 caliber machine gun that now is standard on our war planes. This is one of the world's finest aircraft machine guns. It is capable of firing at a rate of 1,800 shots per minute and weighs approximately 65 pounds. Its projectile, leaving the muzzle at a speed of more than 2,700 feet per second, is capable of penetrating all parts of an enemy plane, including the engine. Equally important, because its cartridges are small but powerful, it can be supplied with large quantities of ammunition per gun, which means that our fighters can fight for a longer period when engaging the enemy.

Consider the clothes that our airmen are wearing. Arctic flying suits, summer flying suits for those in hot countries like Africa and India. Goggles which the pilot wears to protect his eyes. Helmets with earphones and oxygen mask clips in one combination. Electrically-heated gloves and boots. Consider the parachutes for lowering equipment. Individual parachutes for personnel. The sextant, astrograph, compass which the navigator uses for calculating his course. The automatic pilot. Automatic flight equipment which makes possible landings and take-offs without touching the controls. Development of oxygen equipment, ground servicing equipment such as trucks and trailers, life rafts, tool stands. These and a thousand other items are responsibilities of Equipment Laboratory engineers.

Instruments are the "brains" of any airplane, whether it is a bomber or fighter. Now when bombers are required to fly for long distances before they reach their targets, it is necessary that navigation instruments be accurate and minutely timed. The Instrument and Navigation Unit of the Equipment Laboratory is responsible for seeing that our pilots, navigators and their crews have the best instruments that man's genius can design and build. One new development is a navigation aid which helps a pursuit pilot to work out his navigation problems and fly his plane at the same time.

The Parachute and Clothing Unit has developed latest type parachutes for equipment and personnel, and clothing for every climate. One of the newest parachutes is the seat-type that includes a life-raft. Varicolored parachutes are used for lowering equipment to ground forces.

Wright Field experts have designed high-altitude clothing, a buoyance suit, layer-type garments and new shearling suits for ground crews and pilots alike.

War's miscellany, also the problem of Wright Field laboratories, include catapult devices for assisting take-off; life preserver vests; inflatable life rafts; jungle kits complete with machetes, mosquito netting, fishing lines, sulfa drugs and concentrated foods; service trucks and oxygen apparatus.

Synthetic or substitute materials are a full-time job. Typical are nylon and other fabrics which replace silk in parachutes and alternate steels to conserve alloys.

The development of welded steel structures for increasing the strength of the engine mounting and frame of an airplane and the application of chrome-molybdenum alloys to this type of construction were initiated at Wright Field.

Other samples of air pioneering are weight-saving aluminum alloys, X-raying materials, spectrographic analysis, laminated glass, transparent plastics, synthetic rubber, camouflage and fluorescent paints. END

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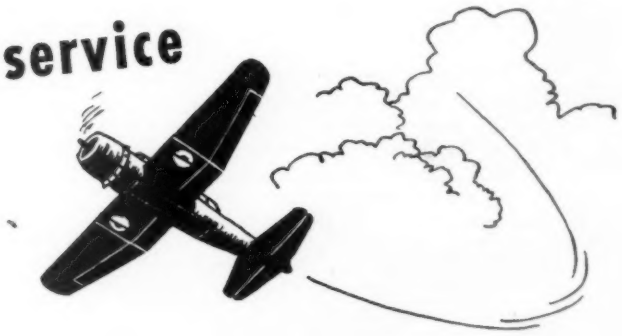

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Although the actual umbrella is being fashioned at hundreds of fields somewhere in England, an aircraft factory in California, a technical training school in Texas, and a primary field in Florida, are producing the spokes—they, and hundreds like them. If we are to have this umbrella, you must do your part here at home. Buy bonds. Get into some phase of the war effort!

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UNITED STATES ARMY AIR FORCES
CIVIL AERONAUTICS ADMINISTRATION
ROYAL AIR FORCE

Air Forces' Proving Ground

(*Continued from page* 131)

Many testing projects are secret or confidential and can only be revealed after victory. They are making victory possible.

The Bombing Section tests bombsights, all types of bombs, bomb fuses, bombing equipment in specific plane types, various bombing attack techniques.

The Machine Gun and Cannon Section specializes in tests of machine guns, cannon, ammunition, gun sights, gun lubricants, turrets, armament equipment on specific plane types, fire control systems, gun firing, fireproof fuel tanks, etc.

The Tactical Section tests the tactical suitability of specific aircraft types and demonstrates tactical techniques for utilizing the characteristics of given aircraft types with maximum effectiveness.

The Radio Section conducts tests of radio sending and receiving apparatus and accessories, electrically-controlled bombing equipment and turrets, radio-controlled planes.

Under the Miscellaneous Section is lumped a host of projects ranging from individual maintenance tools to amphibian trucks. Tests include plane wheels and tires, landing mats, oxygen suits, camouflage of aircraft and balloons, tow-targets, photo equipment, fuel and oil containers, life-saving equipment, food dehydration.

Results of these testing and proving activities grow more apparent each day in the far-flung theaters of global war.

One of the most important developments to come out of the Proving Ground is the delayed-action fuse, which made the technique of skip-bombing practical and highly effective. Skip-bombing was used in the Battle of the Bismarck Sea, against an Axis convoy in the Mediterranean off Tunisia, and is now being used to drive the Jap out of the Aleutians.

The elements of low-level bombing used so decisively at El Alamein and in the Rommel rout were first worked out in the skies above Eglin Field. Eglin Field was first to submerge heavy bombs to produce blast effect against hulls of ships. In this connection, a unique pilot bombsight has made possible a new technique against ships and possibly against tanks on land.

Included within the larger structure of the Proving Ground Command are a number of other significant and vital activities.

Eglin Field and seven satellite fields in its environs serve as a training ground for fixed gunnery groups of the Southeastern Training Center. Magnificent gunnery facilities are maintained and administered by the Proving Ground Command.

Due to AAF expansion there had to be a corresponding increase in the number of pilots trained as fixed gunners. But quality could not sag. Eglin Field has been so successful that the percentage of hits in practice and record was improved *nine* times in one year of war.

This is no accident. Instructors are more efficient. More ammunition has been available for practice. Training films allow students to review errors. Students are war-conscious and realize this is the first step to combat.

Many innovations have been proved successful when applied to the gunnery training of cadets and pilots. First is the Gun Sight Aiming Point (GSAP) Camera. This camera is so mounted that it takes an actual picture of the target through the gunsight as it would be seen through the pilot's eyes.

When the film is developed after the gunnery training mission it enables the student to see how near or how far off the target he was and correct his errors accordingly.

Another war-inspired training aid is a C-3 type Link Trainer with BB shot machine guns firing from each side at a miniature target. Drawn along a track this target resembles a plane in flight. The target veers dizzily, forcing the pilot to turn and bank the trainer as if he were attacking in actual flight. Results gained by this trainer have been pronounced sound by AAF officers, air scientists and ordnance experts.

Newest firing techniques derived from actual combat keep AAF ground and aerial target training abreast of the war.

More and more vital to winning a war that forces us to fight in all climates is the recently activated Arctic, Desert and Tropic Information Center administered by Proving Ground Command.

The center gets latest information on conditions AAF men will have to face in earth's toughest—and hottest—spots. There's no theory about this. Experts who have lived near the

North Pole or under palm trees, who have led scientific expeditions to remote places, pool their knowledge for the benefit of all Army Air Forces units as well as our allies.

What do you do if you're forced down over Greenland

What kind of emergency kit should a flyer take when raiding Burma?

What do you wear, what do you find to eat, how do you overcome tropic fever or frostbite—in short, how do you survive to fight again?

These are the questions every American airman on combat duty may have to ask himself. The center tries to supply the answer in advance.

Specifically, these are problems which have bothered someone in recent months and the center has—

Located all Eskimo villages in unmapped Arctic areas.

Listed all edible plant and animal life of the Arctic and Southwest Pacific.

Told how to maintain radio equipment in the damp tropics.

Published a manual on how to train sledge dogs for transport up North.

Because we must shorten air distances today and tomorrow—and this means flying over the North Pole to reach most of the world—the center's Arctic Section has become vastly important.

Arctic experts include explorers, geologists, photographers, weather men and mapmakers. Long ago they've reported all they know that will help polar flying and now they interrogate returning airmen for every scrap of new knowledge about the Arctic.

Another unique activity is the training of torpedo squadrons, for which admirable facilities are provided. Deep-sea diving and crash-boat facilities are also in the day's work.

At Eglin Field Aviation Engineer Units are formed for overseas duty. A new regiment is established every 16 weeks and one battalion is transferred to overseas duty every six weeks. During training, these men build landing strips, camouflage bombing projects such as fake houses and bridges, and do laborers' jobs.

America's first "ace" in the present war, the late Lieut. Col. Boyd "Buzz" Wagner; Maj. James P. Muri, who sank the Jap carrier *Akagi;* Lieut. Col. Lee B. Coates who flew with the famed 19th Bombardment Group; and Lieut. Col. David L. "Tex" Hill, who flew with the AVG and later the 23rd Pursuit Group, were all project experts at Eglin Field.

Pilots and crew members, after periods of thorough training, leave for combat service, and war-wise airmen return with latest combat developments.

AAF planes are winning on all fronts because their tactical capabilities have been *determined, proven and demonstrated.* Ordnance, armaments, equipment and accessories of all types have had to survive this testing crucible.

American squadrons are waging successful air war not only because they have unexcelled training and fighting spirit, but also because their fighting tools have been proved as the most combat-worthy equipment this country can produce, and because they have been shown how to use those tools most tellingly. The Proving Ground will continue to insure the combat-worthiness of the Army Air Forces' weapons. END

Narrowing the Gap

PRIME Minister Churchill, speaking before the House of Commons, declared that Consolidated *Liberator* bombers (with a range of at least 2,000 miles) were the airplanes used in the "VLR" (very long range) operations against U-boats.

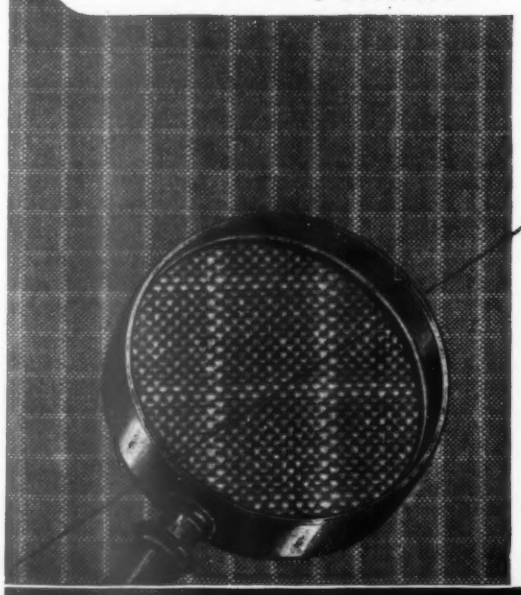
Several squadrons of *Liberators,* equipped with special fuel tanks, operate from bases in the United States and from British Coastal Command bases in Iceland and Ireland. They are credited with having narrowed the mid-Atlantic gap where most of the shipping losses occurred.

Order of Daedalians

PILOTS of World War I who won their wings prior to Nov. 11, 1918, whether now in the armed services or not, are eligible for membership in the Order of Daedalians, a fraternal organization founded in March, 1934, at Maxwell Field, Ala., with the late Brig. Gen. Harold Lee George as the first wing commander.

The organization hopes to enroll all former World War I Army pilots. Col. Charles H. Dowman, wing commander of the order, can be reached in Room 4C-270, Pentagon Building, Washington.

ANOTHER "Feather" IN THE PIONEER PARACHUTE PACK



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Pioneer Parachutes, already 25% lighter and occupying 50% less seating space than ordinary chutes, now through the use of new Nylon "Feather-Weight" Fabric, become even more compact, thinner and lighter than ever. It is another achievement in Pioneer Parachute development.

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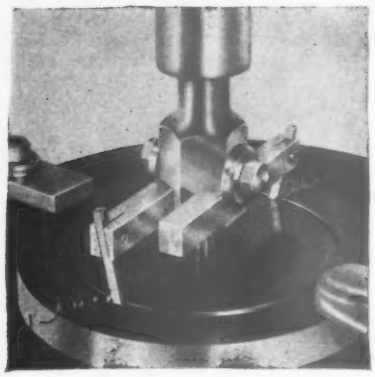

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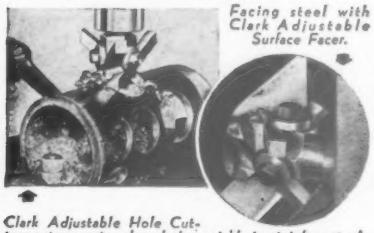

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Air Transport Command

(*Continued from page 185*)

the wartime crops in the Pacific Northwest. The one effective ingredient of an insecticide to combat this plague was rotenone, a root which grows only in South America. The War Production Board called on the Board of Economic Warfare which purchased 110,000 pounds of the drug and sought air transportation to meet the emergency.

In less than a month, without disrupting a single schedule, the entire amount of rotenone had reached the United States and tons of war-vital foodstuffs had been saved.

A famed ship-builder needed 15,000 pounds of copper tubing rushed from New York to Seattle to guarantee the sailing date of a new freighter. Competing demands had slowed production of the condenser tubing required. Five days before deadline, the Transportation Corps, Army Supply Forces, requested air transport priority to Seattle—and set the time limit. With 24 hours to go, the last 5,000 pounds rolled out of the factory and on to waiting transports, Seattle-bound. The shipyards installed the tubing, the champagne bottle broke against the bow on schedule, and the ship sailed on a tide of congratulations—thanks to a co-ordination of air schedules, Army and civilian, that would have been impossible a year ago. Two airline ships and eight ATC cargo aircraft were pressed into service, but the deadline was met.

Day by day, run-of-the-mill requests for priorities cover such emergency items as oxygen tents, serums, medicines, eye glasses, photographic equipment.

Priority responsibility extends to all services operated by ATC the world over, a good part of the foreign mileage operated by commercial carriers, and all of the domestic commercial service. Since priority seekers include the armed forces, government agencies, commercial industry and civilians, screening priority requests becomes almost a phase of international law.

Civilian requirements are just as important as military in some cases. If saving a burning oil well were at stake, a roustabout probably would outrank a general if both could not ride. Anyone whose mission can be certified by a Government agency as wartime necessity may apply for air priority at one of the 16 domestic offices located at important airline cities. Federal departments whose need is frequent may be granted letters of authority which establish domestic priorities direct with the airline. Civilians needing transportation to certain theaters of operation must apply to the State Department, which makes recommendations to Priorities and Traffic.

Military requests for foreign air priority are granted only by Headquarters Control Office of the Priorities and Traffic Division but military establishments have the prerogative of issuing military orders "directing travel by air" which automatically entitle the holder to domestic priority

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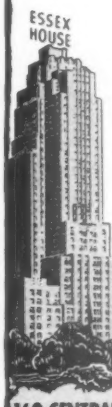

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on the crowded airlines of the nation.

While the Priorities and Traffic Division controls passengers and cargo, Operations actually handles all planes and crews. Each month, when new planes reach ATC, Operations must choose the routes and schedules under which these planes will operate, and determine the distribution of crews.

While operations of the Command resemble those of commercial airlines, strategy brings surprises. Regular schedules are maintained wherever possible. However, these schedules are subject to sudden and absolute demands created by war. Operations must be prepared to pull planes off one route at a moment's notice, re-equip them, and send them out on another route, or even on a special mission.

One such development occurred when President Roosevelt and Prime Minister Churchill met in historic conference at Casablanca. A fleet of four-engined planes was diverted for various phases of this special mission. They flew more than 259,000 airplane miles, equal to 10 times around the world, without a mishap and without injury to any passenger or crew member.

ATC planes fly the world's most hazardous routes, yet pilots and crews have set an impressive record of flying safety. During four winter months, ATC planes flew more than 4,000,000 air miles in Africa alone, carrying 21,300 passengers without the loss of a single plane or injury to any passenger or member of crews. In one eight-month period only one plane was lost in operations in Africa and all aboard this ship escaped injury.

Equally significant to polar operations is the ATC record under winter conditions. A huge Consolidated *Liberator Express* (C-87) which had run out of gasoline made a forced landing in the wilds of northern Quebec. The plane, blown off course during a scheduled flight, put down after midnight on a small frozen lake that had never appeared on maps. The pilot was able to radio an approximate position before the forced landing, which helped rescuers find the stranded aircraft.

Five days later, searchers flew overhead and dropped large kits of emergency equipment to the marooned crew. Ski-equipped planes flew out all personnel except two men who volunteered to remain and guard the plane. Finally a Douglas *Skytrain* (C-47), equipped with special skis, flew in with a small tractor. A runway was cleared with this equipment and the big *Liberator* took off and arrived in the United States two months after its forced landing.

This was the first time a plane of the *Skytrain* type was ever operated with ski equipment—an important development in all polar operations.

ATC's volume of traffic is on a scale that staggers the imagination. Reports from one theater alone show that in a single month ATC planes and other transport aircraft using ATC facilities carried more than 2,500,000 pounds of vital war supplies. Compare this with the 990,000 pounds per month carried by America's largest airline during 1942. For troops in Africa, ATC planes have carried 10,000,000 letters per month.

One of the most unusual units of the command is the Operational Training Unit at Rosecrans Field, Mo. Here, under the direction of the Domestic Transportation Division, crew members who have completed all preliminary training are brought together and welded into operating teams. All the ins and outs of global flying are taught at this school. Pilots learn the right way to make emergency landings on water, beach, desert and jungle; how to maneuver a heavily loaded and unarmed cargo plane under attack by enemy fighters.

For emergency landings in jungle country, for example, it is best to come in with landing gear up, making full use of flaps to land at minimum speed. Pilots are taught to land nose high into the heaviest possible jungle growth to use it for a cushion. Over water, the instructions are to come down gear up without flaps to prevent a diving motion, since the landing flaps are located below the center of gravity. For beach landings, the technique is to come in gear down and flaps down exactly as if making a runway landing. On the desert, come down on the belly: The plane may then be jacked up and flown out again.

The flight engineer is taught the peculiarities of his particular job in long-range flying. He learns specific measures

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to be taken against sabotage; to check cut tires; watch out for crossed wires and foreign material in the battery cells; guard against abrasives in the motors; see that there has been no tampering with the solenoids.

The radio operator learns to use secret codes and ciphers for overseas operation. He gets additional training in servicing his radio equipment while in the air, and foreign radio equipment for any and all theaters.

The navigator learns that on overwater crossings he is the most important man in the plane. Often he must guide the pilot to his destination by sun and stars alone.

After individual training, a five-man crew—pilot, co-pilot, flight engineer, radio operator and navigator—is brought together as a team.

Sometimes one man fails to fit with the others, psychologically or otherwise. He is shifted to another crew and another man is fitted into his spot. This screening process goes on continuously and no crew is ever turned out until it is a smoothly functioning unit. In 50-hour commuting, one misfit personality might spell disaster.

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Twin-Engined	Cargo Weight (lbs.)	Fuel Load (lbs.)	Cruising Speed (mph)	Mileage Per Day
TYPE A	2,000	8,520	155	1,300
TYPE B	9,600	9,600	187	3,740
Four-Engined				
TYPE C	4,300	16,500	157	2,826
TYPE D	10,900	15,600	182	3,276
TYPE E	11,200	15,000	190	3,420

In carrying out its routine operations and innumerable special missions, ATC often pioneers. One veteran ATC pilot set a trans-Pacific speed record when he flew a *Liberator Express* from Australia to San Francisco in 33 hrs. and 27 min. Another *Liberator* completed a round trip from Washington to Cairo in only 111 hrs. and 30 min. This trip was completed in 10 days by a single crew, averaging 11 hours per day flying time.

The chart above indicates the relative efficiency of five types of cargo and transport planes used by the Air Transport Command. END

Saving Aircrews

(*Continued from page* 159)

man is expert in at least two fields. Prior to assignment, each is sent to the Arctic Training School at Buckley Field, Colo.

The course lasts six weeks—half of it the fundamentals of Arctic living and half in specialties. The Arctic demands mountaineers, skiers, woodsmen, guides and trappers who can survive on ice and tundra when wings fail.

Unlike firemen waiting for an alarm, these men don't sit on duty. They inspect emergency equipment, drill themselves and others in what to do in event they have to make a forced landing.

Arctic squadrons use multi-engined transport, utility type aircraft and small single-engined airplanes especially adapted to rescue purposes. Gliders are landed in spaces too small for larger planes. Dog sleds, ambulance sleds, PT boats and snow plows are utilized.

The air-sea rescue section of FCC's safety education division gives advice on operations and maintenance of equipment if a plane is forced down in wild bush or desert country or in the water.

Air-sea rescue service includes technical supervision of squadrons, preparedness training, development of equipment and co-ordination with other rescue agencies.

Just as important as Arctic rescue is how to cope with forced landings at sea. The larger and longer ranged our planes become, the more important it is to safeguard personnel and equipment that face sudden emergencies. The frequency of accidents is less and less on over-water hauls but the cost in men and equipment is much greater per unit.

Today's airmen need to know how to "ditch" multi-engined aircraft at sea, how to bail out, parachute and survive

after hitting the water. From every bomber or transport crew that has lived through disaster at sea, the Air-Sea Rescue Wing has added to its fund of knowledge. These survivors are one reason why the AAF salvages almost all of its manpower and an unbelievably large part of its equipment in such emergencies. Talks, pamphlets, movies and posters all help educate airmen in proper procedure *before* a forced landing happens.

Flight Control's Flying Safety Division is the official AAF agency charged with reducing aircraft accidents. To prevent as many as possible, it teaches, warns, reprimands when necessary. To prevent more, it checks, investigates and reports each accident that happens. Every fatal crash becomes a statistic to make tomorrow safer.

The kernel of the tough nut the Flying Safety Division is cracking is Army Form 14. Every accident, from a dented propeller to a complete wreck, is reported on Form 14. The AAF policy has been to appoint flying officers to investigate and report the accident. Now an expert from Flying Safety may augment the original report, and his findings are given a thorough going-over.

As a starter, the report is skimmed for basic facts. Then real research begins. There are 57 separate items of information on Form 14 which yield a huge volume of statistics.

The evaluation section, for example, allows flying officers to determine the cause of the accident, fix the responsibility and weigh the results.

Then in a vast hopper of tabulating machines, the information is coded, punched and transferred to 3x7-inch cards. Complex accidents require as many as 13 cards.

The card files represent a safety repository—the ore from which safer flying is mined. Out of statistics by the millions come safety regulations, policies, instruction and projects.

All this would be useless without action.

Regional safety officers, as field representatives of FCC, must follow through. They were hand-picked for flying experience, executive ability and initiative to prevent accidents on the spot. This means a lot of traveling.

These experts investigate accidents, of course. They also make contact calls on base commanders—not to snoop, but to help.

A contact call may lead to a safety survey. The regional safety officer checks everything from morale of trainees to the condition of servicing equipment. He reports all findings to the base commander and staff. If necessary, special investigations and follow-up calls may be needed.

Safety research can be staggering. This year Colonel Harris' staff and 23 regional safety officers examined the entire Third Air Force, which subsequently established a safety record.

FCC statistics show four main causes of aircraft training accidents: personnel error, materiel failure, miscellaneous (weather, terrain, etc.) and undetermined. Personnel error alone causes 78.7 per cent of total accidents.

The Command promptly established safety schooling for pilots in training, other Air Forces personnel and the public. This is the Safety Education Division which publicizes the whole FCC story—flight control, weather, communications, air-sea rescue and flying safety—through magazines, newspapers, radio movies, cartoons, posters and airmen themselves.

There's a manual, for example—produced jointly with the AAF School of Applied Tactics—on procedure for ditching medium and heavy bombers. "Swimming through Fire," tells how to survive in a sea covered with burning oil and gasoline. Into parachute emergency kits go one of the two manuals—"Jungle and Desert Emergencies" and "Arctic Emergencies." Among the movies are these titles: "On Your Own in the Arctic;" "How to Live in the Tropics;" "How to Live in the Desert," and "Learn and Live," a record of pilot errors.

Latest sample of streamlined guides is a new pilot's information file on plane operation and maintenance. This has been for years a huge collection of Army Air Forces technical orders chained to every AAF operations desk. Before a pilot can obtain clearance for a flight, he

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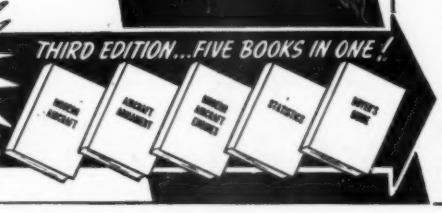

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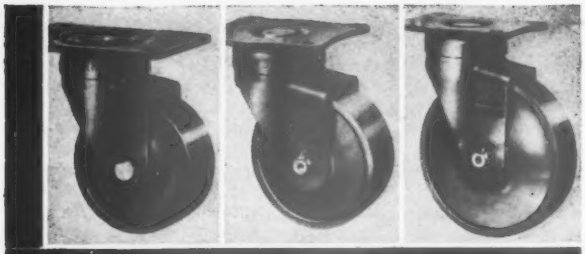

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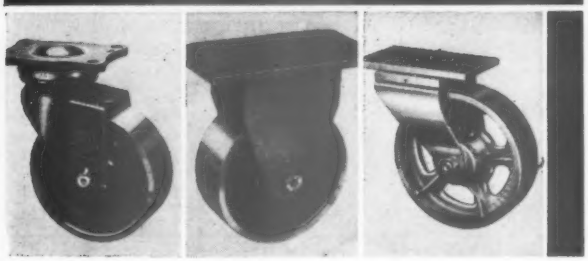

must certify that he is familiar with the File's contents.

Safety Education Division brought out the revised Pilot's Information File without including a single technical order. Into a 240-page full-color loose-leaf notebook of text, diagrams and cartoons is crammed everything a pilot need know. There's one of these files for every AAF pilot.

A special staff function of Flight Control Command is its Medical Section, which aids the medical investigation of airplane accidents. These medical officers want to know if physiological failures caused an accident, and, if so, how to avoid them in the future.

In big things and small, Flight Control Command is General Arnold's answer to uninformed Americans who "demand to know why nothing is done by the Government to prevent airplane accidents."

"Unless something is done to stop the enormous loss of life in air accidents," one man wrote, "Hitler won't need any help to win the war. Something wrong somewhere . . . inexperienced pilots . . . drunken pilots. . . . Look at the daily papers . . . 17 killed, four killed, eight killed . . ."

Here is the answer of Flight Control Command: During the eight-month period from July, 1942, through March, 1943, the *rate* of all Army airplane accidents to hours flown went down.

The *number* of accidents has not decreased, of course. It has increased and will continue to increase as long as the number of planes, pilots and flying hours increases. The only way to eliminate *all* accidents is to stop flying.

During the first nine months of 1942, planes of the Army Air Forces within continental United States alone flew almost a billion and a half miles. This is 135 per cent more miles than were flown by the Army during the entire 10-year period from 1930 through 1939. Despite this great increase, a comparison of the 10 years with the nine-month period in 1942, shows a decrease of almost 10 per cent in the rate of AAF airplane accidents per 1,000 flying hours.

Remember these figures the next time you read of a crack-up. You're seeing more of these accounts than you used to because there are more planes and faster planes in the air.

Remember that during the next 12 months more than 95 per cent of Army Air Forces pilots and cadets in training schools will fly with no personal injury of any kind due to airplane accidents.

Thanks to Flight Control Command, the AAF saves more than 95 out of 100 airmen for combat.

That is our "secret weapon" of Air Power. END

Foreign Trainees

(*Continued from page* 197)

Chinese cadets are anxious to learn American slang. They especially like "okay," "hot pilot," "hot shot," "dodo," and the approving word "sharp."

One Chinese major, instead of saying "yes" in agreement, would always reply to a question, "Now you're cooking with gas!"

In May, 1942, two trains filled with Dutchmen from all over the world arrived in Jackson, Miss., for flight training with the AAF.

After the sudden evacuation from Java following the bitter fighting there, the Dutch wore a varied assortment of army and naval uniforms.

Netherlands airmen included both army and navy personnel. The new arrivals followed no pattern—long pants or shorts, shirts or blouses, riding boots and breeches, white, khaki or blue caps. And the difference in military insignia further confused the situation.

The shorts—the only practical apparel in a hot climate—particularly intrigued the southerners who were unaccustomed to such clothing even though they themselves might have been more comfortable in shorts.

A few naval officers made a week-end trip to New Orleans attired in shorts, white shirt, long white stockings, black shoes. New Orleans was astonished.

"Look, they're walking in their underpants!"

"Hey, buddy, you forgot your pants!"

The Dutch felt uncomfortable. They walked into a photo shop, looked around, forgot what to ask for. The shopkeeper

became suspicious, called the FBI and it took an hour to get things straightened out.

Nearly every member of the Royal Netherlands Military Flying School speaks English. Because Holland is a small country surrounded by Germans, French and English, well-educated Dutch must speak those languages. Those from the Netherlands East Indies also speak Malayan.

They work, train and speak among themselves in Dutch but are avid to trade their language for Americanisms during off-duty hours.

"Turk," for instance, is "dumb cluck." Americans have been quick to share such gems as these: "Geef acht!" (attention); "opde plaats rust" (stand at ease); "rechtsomkeert" (right about); "brigges" (corporal) and "spuit" (gun).

At Jackson Army Air Base, the Dutch flyers approach the final stages of training for aerial combat. The basic, advanced and operational instruction in single- and twin-engined aircraft are taught by their own instructors, many of whom fought with the Netherlands Air Forces during the battles of Holland and Java.

Many U. S.-trained Dutch flyers are back in action abroad. They have joined the offensive with Australian, English and American pilots.

Latin Americans for years have taken "refresher" courses at American fields. Now the war has brought them north in growing numbers, eager to "fly by the book" of the Army Air Forces.

South American student-officers learn slang and flying terms before "schoolroom English." Some samples: "Roger," "Willco," "Contact."

One student was short and stocky, was promptly dubbed by fellow flyers "Senor Cinco por Cinco" (Mr. Five by Five").

The Latin American officers value their flight training highly. Brig. Gen. Gustavo Gonzalez Leon of Mexico, for example, reported to a Texas field and received all the courtesies which are extended to a general officer and a foreign national. Then he removed all insignia denoting his rank and told his American instructors —all junior officers—to treat him as an American aviation cadet.

Close friendships develop between airmen of the United States and Latin America who meet during flying training.

Brazilian students speak Portuguese. Most of them do not understand English. But they are learning to fly despite the language problem.

When an instructor is assigned a group of Brazilian students, his first move is to determine if any can understand English, even if only to a limited degree. If so, this man becomes the interpreter.

Like so many other foreign nationals who are serving at an American Army post, the Brazilian youths learn the give-and-take system of living with Americans.

Members of the Yugoslav army finished an aerial gunnery course this year in Florida. Many of these men participated in Yugoslavia's desperate battle against the Nazis in the spring of 1941.

These soldiers have not seen their families for more than two years. Most of them have heard nothing since they fled from Greece toward Egypt to continue the fight against the Nazis. They are part of a small group which escaped. A few fought with the British in Egypt. Some still wear the uniforms in which they fled, while others bought British clothing in Cairo.

Those who managed to keep their native garb awed the Americans, as their master sergeants had uniforms so gorgeous they often were saluted as generals.

They are paid by the Yugoslav government-in-exile through Lend-Lease. Now they are forming a group in the United States so that they can join our Army Air Forces in the battle against the Nazis. Their first American assignment was their training in aerial gunnery.

Most of them speak little or no English, yet they completed gunnery course with better marks than the average American.

Meanwhile officers of the Yugoslav Royal Air Force are studying aerial navigation in Texas before they go back to the front as members of bomber crews. Their senior officer escaped to Egypt when the Nazis moved into Yugoslavia. Each knows the dreary story of fighting against hopeless odds.

Now history, the training of men for the Royal Air Force provided invaluable assistance at a time when it was most needed by Great Britain. Thousands of youths from England, Scotland and Aus-

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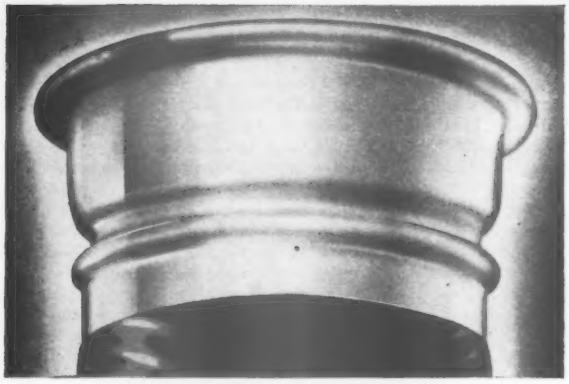

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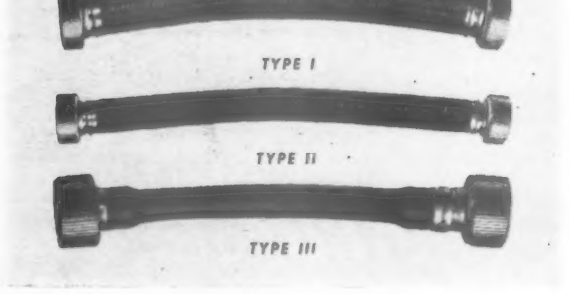

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tralia won their wings in the United States before Empire training could be enlarged.

Several RAF officers stationed at one Texas field as flying instructors were under fire when the war was in its initial stages and most of them endured the Nazi blitz on their homes after the fall of France. Their experiences during those bitter days has helped their own training and now aids the air training program of all the United Nations.

British and Canadian flyers who attend Randolph Field's Central Instructors' School are scrambled with Americans for the sake of language and customs. Such indoctrination practice sometimes works in reverse, though.

One afternoon, startled operators waiting for the familiar "Calling KU18, Calling KU18," heard instead, in clipped British accents: "Hello to tower, hello to tower." And at the end of the message, instead of "Go ahead, KU18," the British pilot politely said: "Over to you, tower."

Today the British "Hello to tower," and concluding "Over" are standard at Randolph Field!

Largely because of different weather conditions, Canadians rely more on instrument flying than do Americans during flight training periods. One field solves this by covering the instrument panel to force offenders to fly by feel and visual perception.

Already under way is the training of French airmen, selected by French army officials in Africa as pilots and aerial gunners. These men include cadets and student officers and are the nucleus of the rejuvenated French Air Force which the United States is helping to train and equip. The French are taking instruction at several AAF fields in the southeast and their training will include armament, radio, and the whole group of other subjects necessary in an integrated air force.

Typical of foreign nationals who have qualified independently for AAF flight training is Aviation Cadet Charles Bech, son of the former president of Luxembourg, now a Nazi-ruled land.

His father, Joseph Bech, now the Minister of Foreign Affairs, fled to London to direct the government-in-exile. Young Bech took up arms and fought in the French army until June, 1940. He escaped from France to England, sailed to Canada and reached Washington, where he enlisted in the Army Air Forces as a cadet. END

Photographic Reconnaissance

(*Continued from page* 191)

Salamaua, Finschafen and Gasmata. At Rabaul 60 ships and an aircraft carrier were spotted, streaming out of the harbor. Two days later the Coral Sea battle made the headlines. Aerial photographs enabled the Naval and Air Forces to strike the Jap decisively.

With no more than five airplanes in the air at any one time, the squadron flew 457 missions in an eight-month period. One photographic flight over Buna eventually cost the Japs 83 airplanes. Quickly processed pictures told a story which sent a swarm of U. S. fighters streaking for the enemy airdrome. Seventy-nine were caught on the ground and four more were picked off in the air. Photographs showed that they had landed to refuel.

One morning the squadron commander received a rush request for complete aerial mapping of Guadalcanal and adjoining islands. The mission was beyond the range of the *Lightnings*, stripped down though they were. A Boeing B-17 *Flying Fortress* was equipped as a mapping airplane. Flying just beneath a high cloud ceiling along the hump of the central range, the big plane, carrying a wide angle camera, completed the mapping in three passages, then went on to Florida and Tulagi Islands. The job was done in one afternoon.

Soon afterwards the first American offensive in the South Pacific was launched. We made our early gains with minimum loss because the photographic reconnaissance made on this flight had supplied the maps.

Aerial photography also helped turn back the Jap land assault on Port Moresby from the Gona-Buna area along the Kokoda Trail. Once the enemy had crossed the Owen Stanley Range, they were confident of smashing through to the Allied base at Moresby. But photographic aircraft made a 45-minute

daily flight along the length of the trail, spotting supply dumps and encampments. When the Japs had cached supplies at 47 installations on the trail's length, Allied aviation attacked the targets.

Eleven days of precision bombing left the Jap forces with neither ammunition nor food. Photography had previewed this action, and photography recorded each step in the Jap defeat.

Technical difficulties arose from the extreme heat, humidity and dust. But these photo experts learned to overcome climate as well as enemy. They stripped the cameras after each mission and coated moving parts with a thin film of oil. Thanks to this, the squadron had only one camera failure in eight months. Exhibiting further initiative when the oblique camera installations broke down, pilots dipped their wings, thus elevating the aerial camera to the required tilt. These low altitude obliques were eagerly sought after for surface vessel identification, and "dicing" techniques were soon perfected by resourceful pilots.

Lack of refrigeration threatens the sensitized materials of photography. In the tropics, AAF cameramen have stored film and paper under cover of bombed structures or other shelter away from hot and blinding sunlight. When ice-making machines have become available in certain theaters, these men improvise refrigerators. They dig holes in the ground, store the film and paper on racks and dump in the ice at frequent intervals. They say it works fine.

Northwest Africa combat operations led Lieut. Gen. Carl Spaatz to praise photographic reconnaissance as one of the most valuable tools available to him. Maj. Gen. James H. Doolittle, commanding the Strategic Air Force, was quick to concur.

"Working without photographic reconnaissance," he said, "is like working in the dark."

In the last stages of the Tunisian campaign the Photographic Reconnaissance Wing was given 60 hours to complete a mosaic of the battle area. Several thousand copies were distributed and were in the hands of unit commanders of the ground and armored forces three weeks prior to the climactic break-through which finally bagged 230,000 Axis prisoners and brought Africa under Allied control. An Armored Corps staff officer declared that the knowledge and information gained from such aerial photography reduced the number of ground casualties by at least 30 per cent.

Commanders were reluctant to advance until annotated photographs were provided for the area to be attacked. Such annotation was made by the Photo Interpretation Section. From a print rushed from the laboratory they prepared an overlay noting artillery positions, search lights, mine fields, tank traps, enemy strong points.

Thus the ground commanders knew at all times exactly what the enemy had prepared for them. Air support and massed artillery fire based on this knowledge was largely responsible for producing the Bizerte-Tunis break-through.

Operational procedure followed in Northwest Africa sets a pattern for the manner in which photography supports strategic bombardment.

An operations officer of the Strategic Air Force sent by messenger a daily list of the objectives to the Photographic Wing indicating the priority, the location and the reason for requesting the desired coverage.

After checking available airplanes and the weather, the next day's missions were set up by the wing commander. By 1900 (seven p.m.) a copy of the missions was sent back to the headquarters of the Strategic Air Force for entry on their operations board.

Assigned missions were flown the following day. All planes usually returned to their base by 1000. Dry prints were made and the first photographic interpretation was accomplished. Prints were then sped back to the Strategic Air Force, usually arriving at 1200 and were used as a basis for the afternoon's raids. Photographs secured in the afternoon were delivered in the same manner by 2000 and were used as a basis for the following morning's operations. Thus, round the clock operations were assured.

Each theater poses its own problems. In Alaska, for example, the below-zero weather on the mainland calls for aerial photographic equipment different from that required by the milder but foggier weather of the Aleutians.

Extremely difficult flying and weather conditions are prevalent west of Dutch

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Harbor. Very rarely is it possible to photograph from higher than 5,000 feet. Because of the relatively concentrated areas occupied by enemy installations, large scale photographs are needed. High shutter speeds are necessary to stop motion and get the needed overlapping exposures at low altitudes. Cameras must be specially sealed against volcanic dust. Because weather conditions change so rapidly after take-off, pilots are now able to control the diaphragm opening of their camera shutters from the cockpit. This enables rapid adjustments for the varying light conditions they will meet.

To obtain more than a small fraction of information which photographic aviation is capable of securing, intelligent co-ordination is required. An understanding of the mission and capabilities of photography by all elements of the command is necessary. The photographic group commander is generally best qualified to act as photographic officer on the staff of the Air Force commander. As such, he advises his commander on mapping and photographic missions and co-ordinates all photographic aviation to insure peak efficiency of the various interlocking uses to which it is put.

Like a newspaper reporter on a beat, photographic planes perform routine coverage of enemy-held positions within operational range. For every minute of the day and night, the Air Force commander wants to know these things: What is the enemy doing? What is his strength? What are his intentions?

Photographs tell the story with unerring accuracy. As the war progresses and the tempo of destruction heaped upon the enemy mounts, the pattern of maximum employment of the aerial striking force becomes clear—it is: "First, photograph; then bomb." END

The Bombsight

(*Continued from page* 107)

moves along the same trajectory as it would if fired horizontally at that speed from a gun mounted on the top of a mountain. Its inertia moves it forward, gravity pulls it down, and air resistance retards both actions.

An instrument used to determine the correct release point must first be given the length of time required for the bomb to fall to the target. It then determines the horizontal speed with respect to the target and multiplies that speed by the time of fall. Result is the distance which the bomb would travel horizontally (with no retardation) during that interval. After mechanically subtracting from that total distance the trail (lag) which also was set in from a chart, the sight produces a range angle (Figure 2). This is the angle formed between the line of sight to the target and a vertical line from the airplane at the proper instant of release.

That, in essence, is the operation of a bombsight. It is merely an automatic speed and distance calculator which interprets its findings in the form of an angle.

Various forms of sights have been developed but they must all perform those functions unless, as in the cruder sighting mechanisms, the bombardier is expected to do some of the calculations. Disregarding these crude types, some of which are entirely satisfactory for minimum altitude (below 1,000 feet) bombing, two general types of mechanisms are used in bombsights for making the necessary calculations. These two types are known as "timing" and "synchronous." Of the two, the timing has proved less satisfactory.

The essential simplicity of a bombsight rests upon one theorem of plane geometry: In two similar triangles the ratio of the length of a side of one triangle to the length of the corresponding side of the other triangle is equal to the ratio of another side of the first triangle to the corresponding other side of the second triangle.

Consider, for example, the right triangle in Figure 2 formed by the vertical line PC from the airplane to the ground at the time of release, the line of sight PT, and the horizontal range CT. Now, still using the sighting angle at P as the apex, consider another very tiny right triangle formed at P by a horizontal wire (or bar) intersecting the vertical line and the line of sight. The ratio of the total altitude PC to the vertical distance between P and the wire equals the ratio of the range distance CT to the length of wire intercepted by the other

two lines. That, in one form or another, is in every computing bombsight, although some are more accurate than others.

In the so-called timing type of bombsight, an object on the ground (generally the target itself along before release time) is "tracked" by moving a cross-wire *back* along the wire for a number of seconds corresponding to the time of fall. The cross-wire is kept in line between P and the object and, at the same time, a second cross-wire is moving forward from the vertical under P. The speed of the first wire corresponds to the ground speed. The distance which it moves along the horizontal sighting wire corresponds to the distance on the ground over which the airplane travels during the time of tracking.

If the rear wire travels forward at the same speed as the front wire moves to the rear, and if the tracking time is equal to the time of fall, it is apparent that the rear wire will move ahead of the vertical a distance corresponding to the actual distance CB which the airplane will travel during the time of fall.

But that is not the correct range because trail has not been subtracted. To accomplish this, we make an adjustment. The rear wire is moved to the rear of the vertical a small amount corresponding to the trail. It starts forward with a handicap which causes it to go beyond the vertical a distance corresponding to the actual range. Now the line from P through the rear cross-wire is the line of sight which should pass through the target at the instant of release. We direct the airplane along the proper course as the target and the rear cross-wire approach each other. Just as they come in line we drop the bomb.

For technical reasons the timing method is not entirely satisfactory. It has been described in detail because the basic ideas of similar triangles and of tracking are the same in both methods. The synchronous method, though better in practice, would merely confuse the basic idea.

One basic difference is the fact that the line of sight in the synchronous sight is always power-operated by a variable speed drive. This speed is varied until the line of sight (generally a telescope) moves automatically to keep lined on the target. The mechanism sets up within itself a release-line-of-sight corresponding to that generated by the rear crosswire in the timing sight. An electrical contact is positioned by this operation so that, when the telescope reaches the generated angle, the bombs are released automatically.

If he wishes, the bombardier can release his bombs manually even while using the synchronous bombsight. Manual release nullifies a considerable part of the advantage of the precision bombsight. There is a significant time interval consumed by seeing, registering the picture in the brain and then reacting appropriately. If this interval is only one-fifth of a second while bombing at 200 m.p.h., the delay will cause the bomb to go 60 feet beyond the point which it would have hit on automatic release. A bombardier's physical and nervous fatigue on a mission may delay as much as one second—an error measured in hundreds of feet.

These advantages of manual operation apply equally to the pilot's job on the bombing run. For the 20 to 40 seconds during which the bombardier is tracking his target, air speed and altitude must be held exactly constant. Responses to direction indications from the bombsight must be precise and almost instantaneous. In fact, flying the bombing run properly is the most exacting kind of instrument flying. It is not improved by the long trip to the target nor by the distractions of enemy fighters and anti-aircraft fire.

Probably the most important single element in precise bombing is accurate flying. Yet even alert pilots have difficulty holding a course within 2° or 3° while at the same time maintaining exactly constant air speed and altitude.

To exploit the capabilities of the bombsight to the full it is essential that flying on the bombing run be as automatic and precise as is the operation of the bombsight. All of our heavy bombers have been equipped with new types of automatic pilots connected directly to the bombsight. The bombardier needs only to track his target by holding the telescope on it.

Instead of turn indications being given to the pilot by a needle on his instrument board, the airplane controls respond instantly. When no turn is needed, the airplane is held rigidly on the reading indicated by the bombsight directional gyroscope. During the approach to the bombing run the same mechanism can be

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used to make the airplane take violent evasive action to confuse ground gunners and enemy fighters.

These innovations are common to precision bombsights. They make it possible for our Air Forces to put into action the only concept of air power which is not utterly destructive and inhuman. Key points, not areas, in enemy war production are all that need be destroyed to cause the enemy to collapse gradually. These points can be most economically destroyed if they are singled out and attacked specifically.

Reducing bombing errors by 50 per cent has the result of multiplying the actual effectiveness of a given number of airplanes by over four times. It enables the job to be done with less than one-fourth of the formerly required number of bombs. Such a real saving in gasoline, planes and lives demands that our unrivalled bombsights be exploited to the limit. END

Strategic Bombing

(*Continued from page 86*)

Instead of invading, however, we start a scientific program of strategic bombing of enemy industry.

At first we will make shallow penetrations, striking primarily at targets which will reduce the air defense power of the enemy—hitting aircraft factories, flying fields and knocking down fighters.

Other targets on our schedule also will be hit, but there will be nothing spectacular about the process. Little or no effect will be seen in the front lines. An invasion started during this period would require the same strength and experience the same losses as if no strategic bombing had been done.

The second phase starts when we have gained the edge over the enemy's production of airplanes for defense, when he is no longer able to increase his defenses and when we can stand the losses of deeper penetrations. Our bomber force must be steadily increased throughout this period which will end when the effectiveness of the enemy defenses is definitely on the down grade.

Again there generally will be little evidence in the front lines of the real effect of strategic bombing. The inner decay will be well under way—but production is normally so far ahead of war use that only isolated evidences of shortages will appear. Still, there will be but slight lowering of the curves of ground force requirements and losses.

Now we start the third phase in which we get down to the business of knocking out the heart of enemy production capacity. It is still not spectacular. A chemical plant shattered here, an airplane factory flattened there, a synthetic oil plant in flames. That is the sort of thing you see in the daily communiques.

Even if you looked down on the whole face of Europe as a map you would see little to attract attention. Tiny puffs of smoke and flame would show where precision bombing was pin-pointing the enemy's vitals like a skillful surgeon removing a tumor from a vital organ.

In this case, however, the work is to create the cancer in the enemy vitals—to cause the internal decay—eventually leaving only a shell, like a pie crust which crumbles away when touched even gently.

During this third phase we really begin to realize dividends. The effects of previous bombing will begin to be felt by front-line forces, so that an invasion started late in this period will require much less force and will experience considerably less loss. If time permits, invasion still should not be attempted while the two curves continue to drop.

The fourth and last phase starts when we have completed the initial destruction of the selected vitals and have started the cleaning-up process on items overlooked. We will also have to destroy a few units which have been built from the ruins of earlier destruction, keeping a sharp watch to see that new sources are not left untouched.

During this phase the two curves drop very sharply until they reach points below which they will never drop. No matter how long this finite bombing continues, it can not completely eliminate the necessity for occupation and final subjugation. There is a minimum force which must be used even if there is no opposition. Also, since it is not possible to take away all of the arms which may be on hand, there will always be casualties in an invasion force. Therefore this period ends when the two curves level off.

Now is the time invasion should begin. To delay longer would waste effort. To invade sooner would cost more than actually necessary.

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cise time table. Yet measured in months it is almost so. Faith and understanding are essential: We must believe in the theory behind strategic bombing. We must understand its limitations and uses.

The Russian front is an excellent example of the costliness of land operations started before strategic bombing was allowed to do its job. From the German angle they had no faith in the idea or they could not conceive of its possibilities, and they have paid in countless dead.

The Russian defense, on the other hand, is being directly aided by strategic bombing. An acute shortage of supplies held up the German offensive and has cramped their operations there as in Tunisia. In both places, for example, Allied air superiority is directly attributable to the results of the bomber offensive over France and Germany, the first phase of which was designed to cut down the German Air Force in the air and at the factories.

We can credit the tank and truck shortage to the same strategic bombing. Similarly, the enemy submarine offensive is being scuttled to a large extent by the attacks on operating bases and construction yards.

Hand in hand with the military aim, the American concept of air force, particularly our idea of strategic bombing, lifts air power from the depths of Axis brutality.

In the first place, the AAF expects to prevent most of the enormous losses which would be suffered on our side without this bombing, a saving beside which the most severe air losses will be infinitesimal.

Second, the result of precision is efficiency measured to economy of effort, allowing available forces to accomplish the task with minimum waste and in the shortest possible time.

Third, we cannot ignore the postwar attitude of the nations toward each other. Bombing at its best causes some extraneous destruction and makes the war and its hates very real to victim populations. Carelessness on our part would intensify and spread those hates which would be stumbling blocks to international amity for years after the actual fighting is over. Precision will hasten the time of new understanding.

Finally, postwar economy is intimately related to the manner in which bombing targets are selected and attacked. Since modern communications have joined all peoples of the world, the standard of living of one nation affects all others. To maintain our own standard as nearly as possible we must assist in rebuilding every other nation, enemy or ally.

We have a potent reason—our own well-being—for defeating the enemy with a minimum destruction of his potential *peacetime* industry.

These are the basic principles of the AAF's war doctrine. Naturally, they are ideals which are diluted by chance and human frailties. But without ideals even mediocre accomplishments are not attainable. It is pointless to argue about what air power can't do. We know we can't do without air power.

With air power we hold the key to victory. END

Instruments

(*Continued from page* 198)

demand from combat zones. The rapid expansion of the Air Forces has necessitated the care of engines by youngsters fresh from farms and factories. Wright Field has worked out engine manuals in language these boys can understand. Tables of operation for each type of engine in service teach the most simply trained mechanic, by reading his instruments, just what each engine can be expected to do and how each type will perform best.

Americans and the British now are the world's best long-range navigators. Every day they make "routine" flights that only experts achieved a few years ago. They are doing it through developments in celestial navigation which would amaze an old-time sea captain.

During the time an old-fashioned surface navigator spent in "shooting" a star sight and working out his position—15 or 20 minutes—an airplane can be 50 miles off course. Celestial navigation at air speeds has to be quicker, more accurate. Instruments and methods also have to be used quickly by one man.

So quick and so accurate are these instruments and methods that today mere neophytes, by old navigators' standards, guide our planes over the top of the world, over the oceans and jungles. Their dependence on celestial navigation is absolutely essential where there are no maps and no radio beams.

In years to come they will drop their bombs on specified targets, not by the bombsight—for the plane will be too high for visual contact—but by the sun and stars. Clear of antiaircraft fire and difficult for enemy fighting planes to locate, bombers will let go when the stars "tell" them, through these instruments of superb accuracy.

Already in service are air position and ground position indicators of such light weight that they have been installed in fighting planes on long over-ocean hops. There is, of course, no room in fighter planes for even the modern air navigator and his tools. Yet a fighter pilot's instruments are so simple and accurate that he knows almost instantly where he is and whether he is on his unseen course. This mechanical navigator has been installed in *Airacobras*, *Lightnings* and *Thunderbolts* that have been ferried in the air to overseas fighting areas.

Much of this development has been in co-operation with the British and much of it has consisted in the improvement of long-existent types of navigational instruments. From the navigator's wrist watch (a far cry from the old-time chronometer of the ship captain's chart room) to the familiar sextant, these refinements have taken place.

The airman's sextant carries its own artificial horizon and gives a direct reading for the altitude of sun or stars to tenths of a second. Old mountains of charts, tables and almanacs have been reduced to a series of "telephone books" which enables the navigator to do his paper work literally on his own knee.

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astral compass. Instead of working out a position from time to time by "shooting" a star, this device enables the navigator to set his course automatically and keep the plane on it by reference to a star.

This whole galaxy of instruments, from engine to navigation, is largely dependent for usefulness on electricity. Pilots still flying can remember when an airplane's single electrical element, the magneto for ignition, was so unreliable that safety regulations still call for two magnetos on every engine. Today a modern bomber, for its instruments and accessories alone —including landing gear and bomb doors —requires current from the milliampere category up to the husky pull of motors measured in horsepower.

A *Flying Fortress* uses as much current as a village of 100 persons.

It was long ago evident that batteries charged from a generator driven by the main engines were an inadequate power source for a big bomber.

Such a battery weighs a quarter of a ton and its life might be as little as 15 minutes, or a mere fraction of that in the stratospheric temperatures where the bombers operate.

Wright Field has installed an auxiliary gasoline engine which supplies this current. It weighs but 125 pounds and will produce power as long as needed in any possible temperature. The generators have likewise been developed remarkably. A weight of 32 pounds per kilowatt is still common in Nazi and Jap equipment recently captured. Our own generators today weigh only about seven pounds per kilowatt and engineers say that by the end of next year they will have them down to two and a half pounds per kilowatt.

"Old Burnt Brushes" is the name of a *Flying Fortress* at Wright Field that shares with the engineers the credit for these developments. Week after week this plane has spent eight hours a day at 30,000 feet, first to find electrical brushes that wouldn't burn out at 50° below zero —which she did—and then to see that all other electrical gear and wiring functioned at such temperatures. She helped discover that most copper wire and other electrical gear function better in such cold.

Every phase had to be proved—lubrication, spark, conductivity—for without perfect electrical gear the big bomber could not start its engines in the first place. It could not operate radio and instruments. It could not fire its guns. It could not open its bomb doors.

How well all these electrical functions of the bomber were devised was shown by a *Flying Fortress* that recently got back to England from a raid over Germany with 200 holes in her. Her radio was operating and all lights were burning.

Wright Field's Electrical Unit is scanning the future, too.

It sees "black light," flare landing paths visible only to friendly pilots, instrument lights that only the pilot can see and other wonders on the way.

A heavy bomber is an expensive schoolroom. Most of them are needed over Germany and Japan where there is no room for learners. Wright Field, therefore, has

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developed the schoolroom's equivalent. Mock-ups of all instruments—flying, engine and navigation—are available in the training centers. There on the ground, regardless of weather "upstairs," students can be shown exactly how their planes will fly and how their flights depend on the proper functioning and reading of their instruments.

A featured performer is the celestial navigation crew trainer. Housed in a kind of planetarium whose dome is a replica of the skies of the northern hemisphere, it reproduces all actual flying conditions for navigator, pilot, bombardier and radio man. The dome moves not only with the apparent motion of the heavens but as it would appear to move to a navigator flying any given course.

The "plane" assumes all possible positions of flight. Beneath it are displayed motion picture replicas of terrain and targets. Radio aids operate on the radio man's loops. Here in this one building crews which must work together learn everything about take-off, flying a long course, coming in over a target and aiming and releasing the bombs.

A student also learns to use the automatic radio range trainer, the navigational training globe, the sextant trainer, the dead reckoning trainer, the pre-flight reflex trainer, the multi-engined taxiing trainer, and gunnery and other trainers about which the AAF keeps mum.

Wright Field's instrument engineers, in other words, not only devise the instruments, but devise the means to teach their use. END

Toward Roomier Planes

BECAUSE the AAF has found that aircrews are less efficient if they do not have sufficient room to perform their duties in the air, engineers are paying increasing attention—within the limit of aerodynamic design—to fitting aircraft to the men who will fly them.

Three artificial manikins of transparent plastic are being used to determine the design of turrets, cockpits, emergency doors and passageways and to influence the location of other aircraft installations at Kelly and Maxwell Fields.

Each of the three dummies is designed as an average-sized pilot, representing the tallest, shortest and the medium of the nearly 3,000 cadets at these fields. The three—Slim, Roger and Shorty—are now used as the standard yardsticks for all plane designs.

Typical problems solved by the models are adjustable pilot seats, location of instruments where a pilot of any size can see them, the hundreds of equipment items involving proper eye level, proper placement of controls for both short-armed and long-armed men, and provision of adequate elbow and knee room, height clearance and cockpit roominess.

Honor Skip-Bombing Pioneer

COL. S. P. HUFF, ordnance officer at the Army Air Forces Proving Ground Command at Eglin Field, Fla., who pioneered in the development of minimum altitude bombing, (under some circumstances described as skip-bombing) has been awarded the Legion of Merit citation.

Used in the highly successful Tokyo and Bismarck Sea bombings, minimum altitude bombing was directed in its development by Colonel Huff and he is, the citation reports, "largely responsible for the present successful employment of minimum altitude bombing by the Army Air Forces."

For many years Colonel Huff was convinced that bridges, railway yards and factory buildings could be attacked successfully by low, fast-flying planes.

One major obstacle was the development of a reliable time-delay fuse which would make it possible for a plane to drop demolition bombs at low altitudes and still allow sufficient time for the plane to escape the bomb blast.

By 1937, this land problem was solved. Then Colonel Huff began to urge low altitude Naval bombing. He believed that a bomb would take a short interval to sink before it detonated, thus permitting the plane to reach a safe distance. In the Bismarck Sea technique, bombs were successfully launched against armored vessels at a height of 50 feet, from planes flying 250 m.p.h.

Colonel Huff then suggested the use of a sight that improved accuracy so greatly that minimum altitude bombing is today an effective method of destroying fast-moving heavy tanks.

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★ AAF DIARY ★

December 7, 1941, to June 28, 1943

1941

DECEMBER 7-8. Hickam and Wheeler Fields, Hawaii, and Clark and Nichols Fields, Philippines and Guam attacked by Japanese aircraft.
DECEMBER 11. A Boeing *Flying Fortress* (B-17) of Colonel Eubank's 19th Bombardment Group scored three direct hits on a Japanese battleship of the 29,000-ton *Haruna* class. The pilot was Capt. Colin Kelly.
DECEMBER 17. Lieut. Gen. Delos C. Emmons, chief of the Air Force Combat Command, replaces Lieut. Gen. Walter G. Short as commander of the Hawaiian Department.
DECEMBER 20. First action of American Volunteer Group. Six Jap bombers downed near Kunming; four others jettisoned their bombs and fled. AVG losses: none.
DECEMBER 25. Col. Eugene L. Eubank awarded the Distinguished Flying Cross "for heroism and extraordinary achievement" in leading a mass flight of *Fortresses* from San Francisco to the Philippines following a route charted a month earlier by Maj. Emmett O'Donnell, Jr., who also received the DFC, together with his men.

1942

JANUARY 5. *Flying Fortresses* scored three direct hits on a Jap battleship and sank two destroyers off Davao, Mindanao Island, Philippines, and hit others ships. All *Fortresses* returned to their bases in the Netherlands East Indies. Remaining heavy bombers and crews had been withdrawn from the Philippines by Maj. Gen. Lewis H. Brereton as soon as it was found they could no longer be operated there and sent to Australia. From there they carried out several long-distance raids on Jap shipping and installations until thrown into the battle for Java.
JANUARY 23-26. *Fortresses* and other Allied bombers sank eight Jap ships in the battle of Macassar Strait.
FEBRUARY 9. American Volunteer Group claims its 101st aerial victory. Jap forces still held in check along Salween River, Burma.
FEBRUARY 19. Sixteen Curtiss *Kittyhawks* intercepted 25 Jap heavy bombers and two fighters over Surabaya, Java, destroying five bombers and one fighter. One *Kittyhawk* lost, pilot parachuting to safety.
FEBRUARY 24-26. Maj. Gen. Lewis H. Brereton flew from Java to New Delhi, via Ceylon, to set up the nucleus of the 10th Air Force in India, which had been activated February 12.
FEBRUARY 28. Balance of General Brereton's bombardment units withdrawn from Java to Australia under General Brett, nucleus of 5th Air Force.
MARCH 4. Brig. Gen. H. H. George's *Kittyhawks* bomb and sink three ships and two launches in Subic Bay, Philippines. Also set supplies afire.
MARCH 10. *Fortresses* and Australian bombers destroy seven Jap ships and fire a flying boat on New Guinea's north coast.
MARCH 15. *Fortresses* bomb Rabaul and other Jap bases in New Britain; *Kittyhawks* destroy three Jap fighters.
MARCH 16. Reports of large U.S. air reinforcements arriving in India.
MARCH 17. General MacArthur arrives in Australia by torpedo boat and plane to take full command of Southwest Pacific, including Philippines. Lieut. Gen. George H. Brett becomes his air chief.
MARCH 24. Flying Tigers destroy 40 Jap planes on Thai airport.
MARCH 29-31. Thirty-three Jap planes destroyed over Timor and New Guinea.
APRIL 3. Six *Fortresses* of the 10th Air Force raid the Andaman Islands, 600 miles across the Bay of Bengal from Calcutta, General Brereton piloting the lead plane. Jap cruiser set on fire, troop ship and installations damaged. No AAF losses.
APRIL 15. Maj. Gen. Ralph Royce led a raid of three *Fortresses* and 10 North American *Mitchell* bombers from Australia to the Philippines in a week-end action. Secret island bases were used. Four Jap ships were sunk, Nichols Field and Davao base damaged, Jap aircraft destroyed.
APRIL 18. Maj. Gen. James Doolittle led a force of 16 specially-equipped *Mitchell* medium bombers on a raid of four Japanese cities, including Tokyo, taking off from aircraft carrier *Hornet*. Heavy damage on military objectives resulted. No planes were lost over Japan, but all were lost before reaching friendly bases in Chekiang Province, except one which landed in Russia.
APRIL 29. AVG's down 22 Jap planes over Lashio. Heavy bombers of 10th Air Force severely damage docks and military installations in Rangoon.
MAY 4-9. 5th Air Force heavy bombers render substantial aid to Naval units in the great battle of the Coral Sea. Nineteen Jap ships were sunk.
MAY 25. AVG flyers bomb Jap concentration on the upper Salween River, Burma. The Chinese troops, badly battered, were in retreat. Six *Kittyhawks* bomb and strafe the crack Red Dragon Jap armored division, setting their gasoline supplies blazing, and knocking out many tanks and trucks. The Chinese rallied and a hopeless defeat was changed into a victory.
DURING MAY. The 10th Air Force assumed defense of Karachi region, Northwest India, co-operated with the British and other Allies in evacuating Burma, and began to fly supplies across the Himalayas to Yunnan Province, China.
JUNE 3-5. *Fortresses*, torpedo-carrying Martin *Marauders*, and Curtiss *Warhawks* of the 11th Air Force, operating from secret bases, saved Dutch Harbor from capture in Jap assault on the Aleutian Islands. Fog-bound Kiska, Attu and Agattu occupied by the enemy.
JUNE 4-7. Battle of Midway. *Fortresses* and torpedo-*Marauders* of the 7th Air Force, based in the Hawaiian Islands, aid Naval and Marine air forces in repulsing powerful Jap invasion fleet.
EARLY JUNE. American heavy bombers reinforce RAF Middle East Command, Cairo, being the first units of the 9th Air Force.
JUNE 12. Consolidated *Liberators* based in Egypt raided the Rumanian ports and oil fields, inflicting heavy damage. Four landed in Turkey and were grounded.
JUNE 15. AAF *Liberators* and British bombers sink Italian cruiser *Littorio* and two destroyers in Mediterranean.
JUNE 29. Heavy bombers of the 7th Air Force smash surface installations on Jap-held Wake Island.
EARLY JULY. Maj. Gen. Lewis H. Brereton flew to Cairo to set up headquarters of the 9th Air Force, with Brig. Gen. Patrick Timberlake as bomber commander, and Brig. Gen. Aubrey Strickland as fighter commander.
JULY 4. American Volunteer Group disbands. China Air Task Force activated under Brigadier General Chennault, with bomber unit under Col. Caleb V. Haynes and 23d Pursuit Group under Col. Robert L. Scott, Jr.
JULY 4. American light bomber crews in six Douglas *Bostons* borrowed from the RAF raided airdromes in Holland in first American bomber action over the European continent.
JULY 8. Lieut. Gen. Carl Spaatz announced headquarters of the 8th Air Force, with Maj. Gen. Ira C. Eaker as bomber commander and Brig. Gen. Frank O'D. Hunter as fighter commander.
JULY 9. American planes aid Chinese in recapturing Nancheng, Kiangsi Province.
JULY AND AUGUST. *Mitchell* bombers added to 9th Air Force bombardment strength. 57th Fighter Group, including the Black Scorpions (64th sqdn.), the Fighting Cocks (65th), and Exterminators (66th) began its spectacular career. The *Mitchells* and *Liberators* carry out smashing raids against Axis shipping and docks at Tobruk, Bengasi, etc. and the *Liberators* against longer-range objectives (ports in Crete, Greece, etc.) to dry up Rommel's supply line. *Warhawks* join the RAF in short-range bombing and strafing attacks and in gaining air supremacy over the desert.
JULY 27. China Air Task Force routs 50 Jap bombers and fighters headed for Chungking.
AUGUST 7. U. S. Marines make amphibious landings at Guadalcanal in the Solomon Islands under protection of Navy aircraft and warships after 5th Air Force bombers under Lieut. Gen. George C. Kenney had prepared for this action by a series of heavy attacks on Jap bases at Rabaul, Buin and Lae.
AUGUST 17. 8th Air Force *Fortresses* bomb railway yards and shops at Rouen, occupied France, without loss. Damage was heavy and the British expressed admiration at the extreme bombing accuracy.
AUGUST 21. Eleven *Fortresses* encounter swarm of Focke-Wulf Fw-190's and Messerschmitt Me-109's over the North Sea, shot down three, damaged or destroyed nine more, with damage to one *Fortress*. All *Fortresses* returned.
AUGUST 27. 5th Air Force *Warhawks* intercept 27 Jap bombers and 20 Zeros at 27,000 feet altitude over Darwin, Australia, destroying four bombers and nine Zeros without loss. New technique was used for success at this high altitude.
SEPTEMBER 1-2. 9th Air Force bombers raid Tobruk and join with RAF in heavy bombardment of Rommel's forces near El Alamein, causing slight withdrawal.
SEPTEMBER 6. Three squadrons of *Fortresses* of 8th Air Force Bomber Command attack airframe factory at Meaulte, one squadron raided the St. Omer enemy fighter airfield, and Douglas *Havoc* light bombers attack the Abbeville airfield. AAF losses: two fighters and three *Fortresses*, the first in 10 raids. Five Nazi fighters destroyed, 38 others probably destroyed or heavily damaged.
SEPTEMBER 12. Heavy, medium and attack bombers, escorted by fighters, carried out four raids on the Japanese airdrome at Buna, base for the drive on Port Moresby. Seventeen Jap planes destroyed on the ground, all antiaircraft positions silenced.
SEPTEMBER 14. A group of *Liberators* escorted by Bell *Airacobras* and Lockheed *Lightnings* heavily bombed and strafed Japanese ships, planes and shore installations at Kiska. Two mine sweepers were sunk, three submarines, three cargo vessels and several smaller craft were damaged. Four Zeros, one small plane and one large patrol plane destroyed, 500 Jap troops killed or wounded.
SEPTEMBER 16. Fifty pilots making up the American Eagle Squadrons of the RAF transferred to the U. S. Army 8th Air Force. The first squadron was organized in September, 1940, during the Battle of Britain. The Eagles downed at least 73 German planes.
SEPTEMBER 21. During July and August, China Air Task Force flyers shot down 28 Jap planes and probably six more and destroyed 30 on the ground in 23 bombing raids in occupied China, Indo-China and Burma without the loss of a bomber.
SEPTEMBER 25. Turn of the tide in the Jap drive in eastern New Guinea. Enemy forced back at a point 32 miles from Port Moresby. *Fortresses, Airacobras* and *Dauntless* dive bombers bomb the strategic Wairopi Bridge, demolishing one end.
SEPTEMBER 29. Ioribaiwa Ridge in the Owen Stanley Mountains recaptured. Three air power reasons for stemming the enemy and rolling him back: (1) Large numbers of troops, equipment and supplies flown in by Troop Carrier Command units in Australia, using Douglas *Skytrains;* (2) Aerial reconnaissance pin-pointed hundreds of caches of enemy food, ammunition and supplies, which were completely destroyed by *Airacobras* and *Kittyhawks* in fast, low-flying, strafing and bombing attacks; (3) the main Jap bases of Rabaul, Lae and Salamaua, and enemy transport ships were under constant attack by *Fortress* and *Liberator* heavy bombers, and *Marauder, Mitchell* and *Boston* medium and light bombers.
OCTOBER 3. Announcement made that *Liberator, Fortress, Marauder* and *Mitchell* bombers, and *Lightning, Airacobra* and *Warhawk* fighters are operating from bases in the Andreanof Islands, 125 miles east of Kiska. Aviation engineers had completed the landing fields with steel mats in record time, fighters landing about the end of August, bombers a few days later.
OCTOBER 8. Report of 9th Air Force activities show that American bombers carried out 90 bombing missions from June 15 to September 30 over Africa and the Mediterranean, dropping 1,580 tons of bombs and

sinking or damaging 37 ships with a loss of five *Liberators*, six *Mitchells* and eight *Warhawks*.

OCTOBER 9. One hundred and fifteen *Fortresses* and *Liberators* of the 8th Air Force, escorted by 500 Allied fighters, bombed German-held industrial plants at Lille, France, in the greatest daylight raid of the war. The bombers shot down 48 Nazi fighters, probably destroyed 38 more and damaged 19. Four bombers were lost. None of the fighters, which destroyed five German planes, failed to return.

OCTOBER 10. 9th Air Force and RAF Middle East planes destroyed 24 Axis planes and damaged 10 in raids on airdromes and supply bases, against a loss of 12 British planes. Beginning of drive to "clear the air," preceding the all-out offensive at El Alamein to begin on October 24.

OCTOBER 13. U. S. Army troops land on Guadalcanal to reinforce the embattled Marines who had held the beach and Henderson Field since August 7. Lieut. Gen. Millard F. Harmon, who had been Chief of the Air Staff until June, was commander of all Army forces in the South Pacific under the overall command of Admiral Halsey. Planes of the newly organized 13th Air Force, under Maj. Gen. Nathan F. Twining, were thrown into the desperate battle. Army, Navy and Marine flyers shot down 33 Jap planes in two days, against two losses.

OCTOBER 21. China Air Task Force carried out a most successful 2,600-mile attack on the Linsi mine installations near Manchuria, in *Liberators* from the 10th Air Force, India. The first U. S. raid in North China.

OCTOBER 24. After four days of the most intense aerial pounding by planes of the 9th Air Force and RAF Middle East, General Montgomery's 8th Army starts its drive to roll the Axis out of Egypt and Libya. The preceding artillery barrage was the greatest ever known in North Africa.

OCTOBER 25-26. *Mitchell* bombers, escorted by *Kittyhawks*, bomb Hong Kong two days in succession, damaging the Kowloon docks, destroying the North Point power station, and blasting the White Cloud airdrome near Canton. Thirteen Jap fighters and probably three others shot down. One *Mitchell* bomber was lost, the only one to be lost in more than 10 months' action ending April 30, 1943.

NOVEMBER 4. Axis forces in full retreat in the western desert. 9th Air Force *Warhawk* fighter-bombers, and RAF *Bostons*, Hawker *Hurricanes* and Bristol *Beaufighters* strafe the fleeing forces and destroy hundreds of vehicles, and blow up supply and ammunition dumps. *Liberators*, *Mitchells*, Vickers *Wellingtons* and Handley Page *Halifaxes* bomb supply vessels in the Mediterranean and in Bengazi harbor in continued action to isolate the Axis forces. In the period from October 1 to November 4, U. S. planes shot down 45 Axis planes, losing six of their own.

NOVEMBER 7. U. S. troops land in French North Africa in powerful force, assisted by the U. S. and British Navy, the AAF and the RAF. Hundreds of paratroopers in 47 Douglas *Skytrain* transports are flown to the scene on a 1,400-mile trip from bases in England. Lieut. Gen. Dwight Eisenhower announced as commander-in-chief of the Allied forces.

NOVEMBER 8. Maj. Gen. James H. Doolittle announced as commanding the U. S. Army 12th Air Force in North Africa, and Lieut. Gen. Frank M. Andrews as overall commander of U. S. Army air and ground forces in the Middle East, Maj. Gen. Lewis H. Brereton retaining command of the 9th Air Force. Lieut. Gen. George H. Brett replaced General Andrews as Chief of the Caribbean Defense Command, Canal Zone.

NOVEMBER 22. The largest formation of U. S. bombers ever to operate from an air base in India attacked the Japanese-held railway center at Mandalay, Burma, inflicting heavy damage. No planes were lost.

NOVEMBER 25. 12th Air Force Lockheed *Lightning* twin-engined fighters destroyed 14 Axis planes in Tunisia with no losses.

French pilots in Morocco are being armed with new Curtiss *Warhawks*, a fighter said to most nearly harmonize with their methods of training and fighting tactics.

Chungking reports that U. S. "Skydragons" of the China Air Task Force have successfully attacked widely separated Japanese installations in the past five days, including Lungling; Haiphong, French Indo-China; Sanchu Island (near Canton); Tienho airdrome, Canton.

NOVEMBER 26. Nine *Liberators of the* 10th Air Force fly 1,500 miles round trip to raid an oil refinery at Bangkok in the first American attack on Japanese-held Thailand.

DECEMBER 5. Lieut. Gen. Carl A. Spaatz arrived in North Africa from London to reorganize the Allied air forces in Tunisia. Maj. Gen. Ira C. Eaker, Chief of Bomber Command, took over command of the 8th Air Force in London.

Liberator heavy bombers of Major General Brereton's 9th Air Force in the Middle East inflict heavy damage on Naples in the first American attack in history on Italy proper. One cruiser was sunk, a battleship and another cruiser were badly crippled, and harbor railway installations were smashed. No AAF planes were lost.

DECEMBER 10. Allied forces complete the occupation of Gona, northeast New Guinea. Buna fell five days later.

DECEMBER 17. *Fortresses* and *Havocs* escorted by *Lightning* fighters raid Bizerte, Tunis, Gabes and other Axis bases in Tunisia on the sixth day of the 12th Air Force's aerial offensive. Only one plane was lost.

DECEMBER 24-26. China Air Task Force *Mitchells* raided Tengchung, Japanese-held base in Yunnan province (24th). Christmas Day the Japs sent fighters and bombers over an auxiliary airfield in Western Yunnan, *Warhawks* downing three bombers and five fighters at a loss of two planes. *Mitchells* also raided Lashio, Burma, three times within the week, inflicting heavy damage.

DECEMBER 27. A considerable force of *Liberators* raided Bangkok, Thailand, hitting the arsenal, power plant, the airfield and naval dock area, starting large fires. No planes lost.

DECEMBER 28. 5th Air Force bombers sank or set on fire four Japanese ships in a night attack on Rabaul, New Britain. Twelve latest type *Lightnings*, making their debut in New Guinea, shot down 15 out of 40 Jap Zeros and dive bombers in the Buna area.

DECEMBER 30. 8th Air Force heavy bombers carried out a daylight raid on the Nazi U-boat pens at Lorient, Bay of Biscay, shooting down

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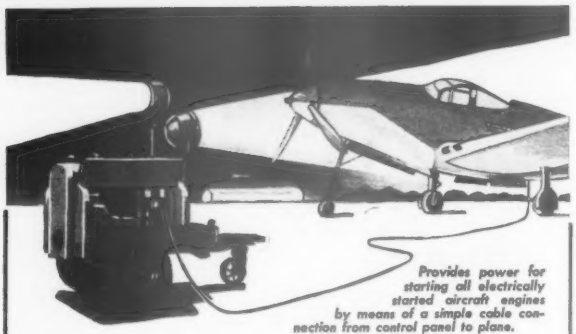

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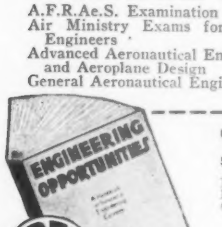

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19 German fighters. Three bombers were lost. Since beginning of these raids on August 17, *Fortresses* and *Liberators* based in England have shot down more than 200 Nazi fighters.

1943

JANUARY 6-7. A Jananese convoy of two light cruisers, four destroyers, and four transports attacked by *Fortresses, Liberators, Mitchells, Marauders, Lightnings* and *Airacobras*. Seven direct hits on transports, two sunk, third probably sunk. Twenty-nine Jap planes shot down, 11 probably destroyed. AAF losses: one shot down, one missing, one seriously damaged, 13 slightly damaged. Dress rehearsal for Bismarck Sea.

JANUARY 27. *Fortresses* of the 8th Air Force dropped 130 tons of high explosives on the port of Wilhelmshaven in the first AAF raid against Germany proper. Twenty-six enemy planes destroyed, five probably and 10 damaged. Three *Fortresses* lost.

FEBRUARY 18. Under the general direction of Air Marshal Tedder (General Eisenhower's air chief), the U. S. 12th Air Force and RAF units in Africa merged as the Northwest African Air Forces. Lieut. Gen. Carl A. Spaatz headed up the NWAAF, with Major General Doolittle in charge of the Strategic Air Force and Air Vice Marshal Coningham commanding the Tactical Air Force.

FEBRUARY 22-25. Northwest African Air Forces flew 1,109 sorties in support of Allied troops and played important part in driving Rommel's forces back through Kasserine Pass in Tunisia.

MARCH 1-4. The battle of the Bismarck Sea. Long-range bombers of General Kenney's 5th Air Force spot Jap convoy proceeding toward New Guinea (March 1). Crews and pilots of 162 Allied bombers and fighters repeatedly attack convoy and air cover, bomb airdromes at Lae, Finschafen, Gasmata. Heavy, medium and light bombers show unprecedented team work, especially in minimum altitude skip-bombing (March 2-3). Ten warships, 12 transports, 15,000 troops destroyed. Fifty-five Jap planes shot down, 25 probably destroyed, seven damaged. AAF losses: one *Fortress*, three *Lightnings* (March 4).

MARCH 10. 14th U. S. Air Force activated in China, replacing the China Air Task Force operating under the 10th Air Force in India. Brig. Gen. Claire Chennault continues as commander, becoming a major general on March 25.

MARCH 18. Ninety-seven *Fortresses* and *Liberators* of the 8th Air Force attack Vegesack U-boat building center, near Bremen, dropping 268 tons of high explosives. Seven submarines were destroyed in the ways, others damaged. Twelve shops were completely destroyed, six others heavily damaged, including the powerplant. Fifty-two enemy planes shot down, 20 probably destroyed, and 23 damaged, with loss of one *Liberator* and one *Fortress*. Air Chief Marshal Sir Charles Portal described the raid as a complete vindication of daylight precision bombing.

MARCH 19. Lieut. Gen. Henry H. Arnold, commanding general of the Army Air Forces, confirmed for the promotion to the temporary rank of a full, four-star general, the first flying officer to win such rank.

APRIL 10-11. Sixty-six Junkers Ju-52 transports and 13 German fighters shot down over Tunisia, with no AAF losses.

APRIL 11-14. During this time Japan made three heavy attacks on our New Guinea bases, including Oro Bay (with 45 planes), Port Moresby (100 planes), Milne Bay (80 planes), losing 82 planes and 27 probables. AAF losses: nine planes.

APRIL 17. *Fortresses* dropped 250 tons of bombs on Focke-Wulf aircraft works at Bremen. Strong enemy fighter interception and heavy flak encountered. Five of the seven major structures of the factory destroyed or damaged severely. Sixty-three enemy planes shot down, 15 probably destroyed and 17 damaged. AAF lost 16 *Fortresses*.

APRIL 18. Curtiss *Warhawks* of the 57th Fighter Group and Vickers *Spitfires* intercepted a large formation of Ju-52's with a strong fighter escort. In a dramatic 20-minute action 74 planes were shot down, including 58 Ju-52's, 14 Me-109's and two Messerschmitt Me-110's. Nineteen transports and 11 fighters were damaged. AAF losses: Six *Warhawks* and one *Spitfire*.

MAY 3. Lieut. Gen. Frank M. Andrews, distinguished flying general and commander of all U. S. forces in the European theater of operations, killed in an airplane accident in Iceland.

MAY 7. Triumphant Allied troops capture Tunis and Bizerte, striking in overwhelming force with the aid of the greatest supporting aerial barrage in history, more than 2,500 sorties being flown.

MAY 10. America's heaviest single-engined fighter, the Republic *Thunderbolt*, officially announced in action against the enemy, having accompanied *Fortresses* on the Antwerp raid. No planes were lost.

MAY 14. American bombers, roaring out over Europe, struck their heaviest blow of the war to date with four separate, closely co-ordinated attacks on naval, airfield and factory targets in Germany (Kiel), Belgium (Antwerp and Courtrai) and Holland (Velzen).

JUNE 1. American fighters and bombers of the 14th Air Force play a decisive part in the battle of Hupeh-Hunan, removing threat to Chungking and to China's "rice bowl" area.

JUNE 11. Maj. Gen. Ira C. Eaker announced that the 8th Air Force had doubled its strength since March and would be doubled again by October. In May the ratio of five enemy planes to one was maintained. Percentage of loss in 10 months of operation has been less than four.

JUNE 12. After 19 days of terrific pounding from the air, Pantelleria surrenders unconditionally under terms of Lieutenant General Spaatz. First case in history of a well-fortified citadel being subjugated by air power, with some support of sea power, without action by ground forces.

JUNE 18. Flyers of the 13th Air Force, Navy and Marines in the South Pacific shot down 77 out of 120 Japanese planes over Guadalcanal; antiaircraft accounted for 17 more. Our losses were six airplanes.

JUNE 26. More than 50 *Liberator* bombers of Major General Brereton's 9th Air Force (Middle East) carried out a raid on the big German airdrome of Sedes near Salonika without loss.

JUNE 28. More than 100 *Fortresses* made the heaviest single attack of the entire Mediterranean war by smashing the port of Messina, Sicily. Raging fires guided British heavy bombers to the target in a devastating night raid.

END

Out of Great Emergencies . . . New Leaders Arise

AMONG FREE MEN, always, new leaders arise to meet the challenge of great emergencies. These are the men who deny the "don'ts" and the "can'ts" of conservative years . . . who dare the impossible.

There were several such "impossibilities" in the aluminum industry, before Pearl Harbor. It was "impossible" that America's war needs could ever exceed what was then considered a huge national production capacity . . . or that imports of foreign bauxite could be stopped . . . or that our bauxite could be turned into purest aluminum.

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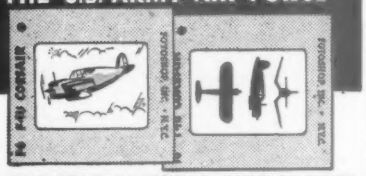

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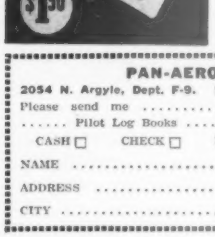

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General Arnold

(*Continued from page 50*)

to exercise direct control of the plane during the bombing run, our bombardiers dropped some 250 tons of bombs, hitting seven out of 15 submarines actually in the construction ways, and inflicting heavy damage on the power plant and 17 other key buildings.

On May 14, in the 1,000-mile round trip mission against the U-boat yards at Kiel the actual bombing results were even better. About 287 tons of bombs were dropped by 125 of our heavy bombers, and reconnaissance photographs indicate that nearly every bomb landed smack in the target area, inflicting terrific damage.

A secondary result of these engagements (each one of which is sufficiently important to call an air battle) is that the Luftwaffe has been forced into defensive action. Single-engined day fighters of the latest types, including souped up, heavily armed versions of the Messerschmitt Me-109 and Focke-Wulf Fw-190 are being thrown in with desperate determination to stop these bombings at any cost, and many such fighters have been shifted from other areas. We have proved that they cannot stop us. Our heavy bombers are shooting them down in substantial numbers, and recently we have had the added protection of a number of modified fighter versions of the *Flying Fortresses*, so heavily armed they are called "flying hedgehogs." Knocking the Luftwaffe out of the skies continues to be one of our main jobs. During April, May and June our bombers and fighters shot down 821 German planes over Europe, against 183 of our own, a ratio of 4½ to 1; including "probables" it is about 6 to 1. In order to hold their own the Luftwaffe would have to destroy our planes at the ratio of 2 to 1. There is growing evidences that the Luftwaffe, spearhead of the early Nazi triumphs, will prove to be the Achilles heel leading to the collapse of Hitler's ill-fated "new order."

An outstanding example of the possibilities of strategic bombing dealing a powerful, paralyzing stroke, is the great attack on the Rumanian oil refineries at Ploesti by 177 *Liberators* of the 9th Air Force, Middle East. It is the most important single air blow of the war to date.

Two air engagements which took place during the first half of 1943 will have an important place in the history of warfare. The first is the remarkable victory of the Bismarck Sea during the first four days of March in which land-based air power alone decisively stopped and then annihilated an enemy invasion fleet. The second was the virtually all-air conquest of Pantelleria in June, another milestone in the development of military aviation.

The Bismarck Sea victory was notable for its completeness, for the perfect integration of various parts of the attacks and as an example of direct air assistance to ground forces by destroying an enemy division, with its supplies and equipment, before it could even get into action.

Probably the most far-reaching effect, however, was its conclusive demonstra-

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tion of the effectiveness of minimum altitude bombing, sometimes referred to as skip-bombing, a phrase which is hardly descriptive of the main features of this important new technique. Developed at Eglin Field early in 1942, each theater has worked out its own application of the basic theory. It has been used with great success in the Mediterranean and the Aleutians as well as the Southwest Pacific, and has its applications to land as well as sea operations.

On the island of Pantelleria the all-out air assault was so overwhelming and so concentrated that the defense was saturated and surrender became inevitable. This engagement has often been compared to Crete, but the difference is fundamental. Crete was lost to airborne troops who landed and fought it out with defending ground troops. The white cross on Pantelleria's battered airdrome before a single soldier or sailor landed is a symbol of the ability of air power to capture any citadel once its own supremacy in the skies is established, and provided a sufficiently sustained and powerful air assault can be brought to bear against it. It is simply a matter of mathematics (or physics). While air assault is not without cost, this type of warfare is actually cheapest on all counts and it is by far the greatest economizer in human lives.

The American doctrine of total air power, while emphasizing the tremendous possibilities of strategic bombing, has always included the idea of close co-operation with ground forces as a team. In our development of attack aviation in the early '20's it was established that the air arm was not to be regarded as merely for support of ground actions, but that it could act by itself, under the high command, by attacking from the air the same objectives as the infantry and artillery attacked from the ground.

This principle has seen its finest development to date in the operations of the Tactical Air Force in the Tunisia campaign. General Montgomery of the British 8th Army was convinced that to secure the concentration and the flexibility required of air power on the battlefield, the air operations should be under an air commander, the ground operations under a ground commander, and that both of these officers should be on the staff of the commander-in-chief of the theater and work together in the closest possible co-operation. This was done in Tunisia, and together with the work of the Strategic Air Force and the equally vital (if less spectacular) services of the Coastal Command, the Air Service, Air Engineer and Troop Carrier units, the Reconnaissance Wing and the Operational Training Command, the results were terrific. A pattern for victory has been clearly established.

Another highly significant development of the present war is that at last logistics, the art and science of military supply, has taken to the air on a grand scale. This does not mean, of course, that any considerable bulk of the requirements of the Air Forces (or of the Army generally) are being flown to the combat areas in transport planes. Shipping is vital in this war of immense distances, and our country's outstanding performance in exceeding its heavy quota of merchant ships and getting the stuff to our widely scattered theaters of operation will constitute no small part of the final victory. However, it is unquestioned that the remarkable spread of American air power to 10 fighting fronts in all parts of the world within less than a year of the attack on Pearl Harbor is very largely due to the rapid pioneering development of the Air Transport Command. Organized in May, 1941, to ferry lend-lease planes, the ATC has expanded in a little over two years to a world-wide airline operating more than 110,000 miles of airways over five great routes, with all the airfields, hangars, gasoline storage facilities, communications and weather reporting service that this implies. Over these routes a steadily increasing stream of combat planes is being ferried daily, and impressive quantities of high priority supplies and equipment, besides key personnel, are transported to the fighting front.

The articles in this issue give in as great detail as is permissible the full story of the development to date of the Army Air Forces at war. It is hoped that a vivid impression will also be gained of the splendid spirit of officers and men of the Air Forces and the unequalled teamwork of all its branches. END

Design with Models

TINY models are dictating the designs for various types of maintenance equipment, small service trucks, portable repair shops, bomb cradles and other miscellaneous field devices used by the AAF, reports "Air Forces," official journal of the Army Air Forces.

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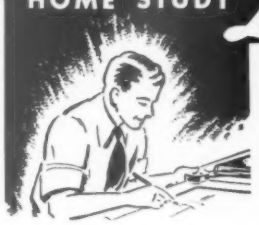

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Lessons from Combat

(*Continued from page 77*)

early *Fortress* crews improvised their own tail guns. For a long time it was a secret that all *Fortresses* were so equipped. Time after time flights of Zeros or Messerschmitts came in on the tails of new *Fortresses* basing the boldness of their attacks on the reports of enemy survivors of previous attacks—only to find by then the *Fortresses* carried a truly lethal sting in a pair of .50 caliber machine guns in their tails.

The development and almost universal adoption of the .50 caliber machine gun itself is another example of the efficacy of battle reports and the way they were handled. We had scarcely an operational plane equipped with .50's—they all carried the .30's which the British had found and still find effective for their own uses—when the Japs struck at Pearl Harbor. Those few planes equipped with .50's however, proved so devastatingly effective that quick decision was reached to change over all such equipment.

The effects of that decision reached far beyond the limits of the Air Forces. It meant vast changes in the manufacturing procedures of hundreds of industrialists. Not only the machines making the guns but the machines making the ammunition, and the airplanes carrying the new guns into battle had to be changed. For the weight of a .50 and its ammunition, its recoil and many other things about it differed so widely from that of the .30 that the change required major re-design in many of our airplanes.

Also it required major re-design of attack tactics on the part of the enemy. They found that their planes were blasted from the sky before they could get within range of ours.

The enemy is neither stupid nor static. He is capable of more than one change in tactics. He has already done things that enable him to attack the latest B-17 and to get into range sometimes despite the fire superiority of our .50 caliber machine gun. Thanks to the organization of our operations, commitments and requirements, however, steps have already been taken to checkmate the enemy's progress. What these are and how they have been made are things that he will eventually learn.

This function of our Air Forces had a fine model to follow. The British did just this in the Battle of Britain. They adopted changes from their battle reports and made those changes effective in the sky before the Germans could learn about them. No small part of the credit for that great defense against an apparently overwhelming force goes to this division's opposite number in the British Air Ministry—and to the British manufacturer who acted on its analyses of reports from the front.

Our problems, however, were vastly more complicated than the British because of the factor of distance. The battles from which the British learned were, all too often, fought in their own front yard. A British pilot might actually parachute into the plant of the manufacturer

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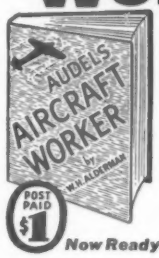

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who made his *Spitfire* or *Hurricane*. Returning from a sortie, a gunner or bombardier might have been but a taxi ride from the Air Ministry. Hence changes and modifications could be made with lightning rapidity.

Our difficulties were demonstrated even before we had to face them in our own operations. British reports from the front revealed ways to improve the American equipment they were using. As a result, most of the manufacturers who were supplying materiel to the British, from planes and engines to instrument and food, established their own service branches in England or wherever their materiel was being used.

Such a policy has been continued in our own war effort. But the effort is so global that closer co-ordination was required. Hence the organization of OCR. Though our boys may parachute to some remote Pacific island or crash-land into some African or Asiatic desert, their information and recommendations are only at cable or radio distance from headquarters.

At headquarters their experiences are compared with those of others. From that comparison comes the order for change and thus the fulfillment of the AAF policy of satisfying the customer who is our fighting pilot, gunner, engineer, radio man, crew chief, mess or medical officer.

Reports from the front are by no means confined to praise or blame for existing equipment. Many an idea for something absolutely new has reached Washington from the boys who are actually doing the fighting. However novel or startling that idea is, it receives full attention. It is assessed first from the viewpoint of practicability—can it be done? Then it is weighed as to usefulness—is it something that will help solve the tactical or strategic problem confronting us? Or is it something that will present a new tactical or strategical problem altogether—something for the enemy to sweat over and try to solve? Then, have we the manufacturing facilities and the raw material to make it? Is it important enough to create new facilities or to divert raw materials or develop new ones?

As these questions are answered the proper steps are taken to give the idea form and effect. The division may call on one or more of the multitude of design and experimental facilities it has at its command from the drawing boards and laboratories and wind tunnels and test fields at Dayton, through the various scientific establishments, universities and manufacturers of the country.

A prototype will be designed and developed to meet battle-born specifications. It will be tested in every possible way that peaceful America can provide. And then, if there is any doubt, prototypes will be sent to the theaters and once again the stream of front reports will flow into the Division of Operations, Commitments and Requirements. There, changes in the device may be recommended. Then the problem of production will arise. How many of these will we need? On that answer the Materiel Command will lay its plans and, sooner than the enemy can expect in most cases, the new device is

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helping to break down his fighting spirit.

Or the device, be it airplane or cotter pin, may be such that it requires a whole new concept of our methods of fighting in the air. If it is, a new operations strategy or tactic is worked out on the training fields. It may involve the selection of a whole new class of personnel and its training. If it does, the division's directive goes to the personnel and training divisions and is soon carried into effect.

The effectiveness of this use of reports from the front seems well proven by the overall result. Somehow or other the free nations have proven themselves more adaptable than the unfree. The Luftwaffe started the war with an indubitable numerical superiority and a considerable superiority in quality.

Yet, using their reports from the front in the easy fluid way in which democracies do seem capable, the air forces of the United Nations are already imposing their will through airplanes and devices scarcely dreamed of a few years ago. The ruins of Hamburg and the Ruhr, the vanishing empire of Italy and the vanishing fleets of Hirohito are writing in history the effect of lessons from combat more tellingly than they could ever be written here. END

New Transport Markings

CERTAIN yellow plane markings have been adopted by the Domestic Transportation Division of the Air Transport Command to make their planes engaged in training and cargo operations more easily recognizable from the air and ground.

All planes of the Command used in transition transport training, as well as those ships in the United States and on domestic routes from Brownsville to Panama engaged in cargo operations, will have their vertical tail rudders painted yellow with 18-inch-high black figures giving the ship number. Girdling the fuselage just behind the cargo or loading door will be a 42-inch yellow band, with the circular insignia of the Air Transport Command painted in the center of the stripe on both sides of the plane. Between this yellow stripe and the tail assembly will be placed the white and blue circular star insignia of the U. S. Army Air Forces.

The engine cowling on all ATC planes in this category will be painted yellow and each ship will have a yellow diamond on the nose, approximately 20 by 40 inches in size with four-inch-high black figures. In the case of twin-tailed types both tail rudders will be painted yellow. For general information, the various types of training planes common to Air Transport Command operations are the Douglas *Skytrooper*, North American *Mitchell*, Cessna *Bobcat*, C-48 and C-49.

These markings, the Air Transport Command points out, are not to be confused with the yellow identification markers in use by the Troop Carrier Command. The outstanding differences are that on Troop Carrier Command planes the stripe girdling their planes is farther back on the fuselage and the wing tips are painted yellow.

Dear Joe:

Still bronco busting!

Thought I'd left all that behind at the Lazy Y, but get a load of me in that snap.

That's an Indian Motorcycle I'm riding -- and believe me, it's a great machine. Easy and safe to handle, and it stands up under this cross country stuff like nobody's business. An Indian ought to last forever on a decent road!

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Buying Warplanes

(*Continued from page 129*)

paper that might mean hundreds of thousands of dollars to some manufacturer, yet containing all the necessary information to make a deal. Once it was used only for orders up to $500 with two months to deliver. War has changed that. Now it can be written for as much as $500,000. It works quickly. An order for $500,000 worth of spare parts for airplane engines can be completely initiated, approved, filed and put in the mail in a matter of minutes. This happens many times daily.

The short form contract is a written agreement with a manufacturer for any amount and any delivery time. It could be used for procurements of $500 and others of $25,000,000. Its delivery time could be 20 days or three years.

The formal contract is also good for any amount and for any length of time. It is more flexible, more complex than the short form contract. Special clauses may cover reams of written legal matter. Transactions covered by formal contract often involve billions.

Contracting officers have one rule on contracts: "Know what you want. Make sure the manufacturer knows what you expect from him. Make sure he knows what to expect from you." Common sense has saved millions for both parties.

One obstacle—priorities—often disrupts all purchasing methods. Just as they change your personal buying habits, priorities also hit the Army Air Forces in its procurement program. This is the prime worry of the Procurement Division. The busy Priorities Branch of the Contract Section is charged with the assignment of preference ratings to all contracts and purchase orders placed at Wright Field.

Every contract that leaves Wright Field has a priority stamped on it. However, not Wright Field but the Army-Navy Munitions Board must determine the relative order of importance which this contract has to the war effort. The ANMB classifies battleships, carriers, bombers and fighters—and all other weapons in their order of importance to the war program, and assigns a broad priority classification to each one of those categories. This priority is flexible so as to include the up-to-the-minute needs of our fighting men everywhere.

"Priority," says one officer, "is what makes the wheels go around when a shortage of materials exists. We have a lot of materials in this country but we have a hell of a lot of weapons to make. There just aren't enough raw materials to make airplanes, battleships, tanks, guns and the other four million and one weapons all at the same time."

Despite priorities and many another wartime headache, the Procurement Division is getting the job done. This year its buyers will spend the Government's dollar for the best planes, the best engines, the highest-rated fuels, the most efficient propellers. Picked and teamed together by intelligent buying—these will give us the greatest mass air power ever known. END

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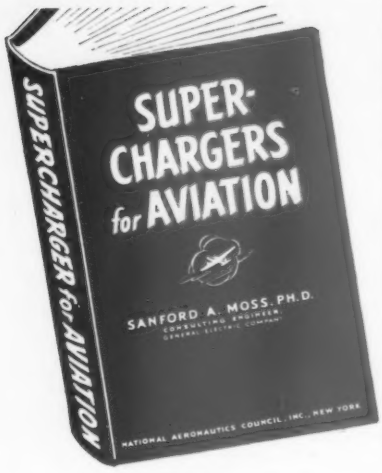

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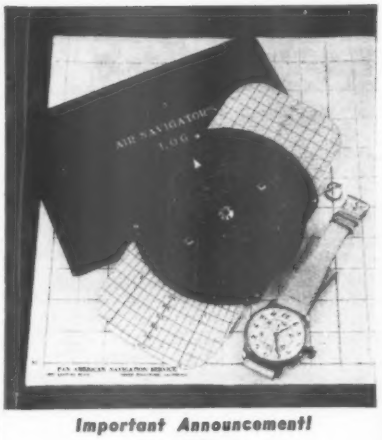

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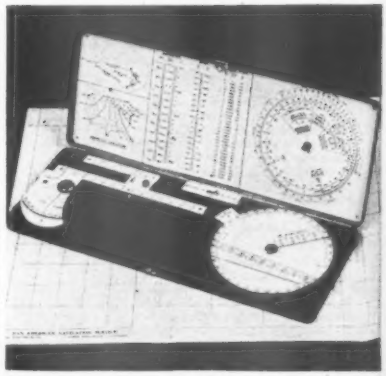

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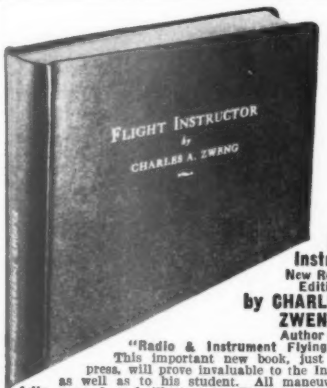

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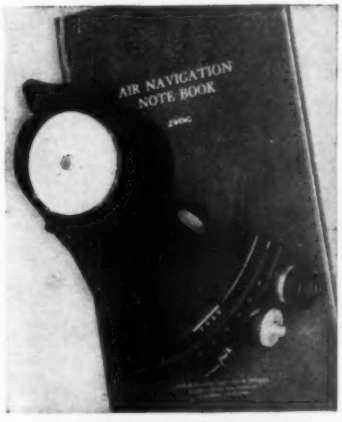

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Flight Superintendent
Station Manager
Chief Pilot
Operations Manager
Traffic Representative
Navigator
C.A.A. Inspector
Flight Instructor

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